MITSUBISHI ELECTRIC

Energy Measuring Unit

Model EMU4-BD1-MB
EMU4-HD1-MB

User's Manual (Details)

Safety precautions

Thank you for purchasing the Energy Measuring Unit.

- This manual describes setup and usage for the Energy Measuring Unit. Before using the product, please read this manual carefully to ensure correct use. Especially, in the case of where this unit is to be installed, please read "1. Precautions for Use" to ensure correct use.
- Make sure that the end users read this manual and then keep the manual in a safe place for future reference.
- Make sure to deliver this manual to the end-user.
- If you are considering using this unit for special purpose such as nuclear power plants, aerospace, medical care or passenger vehicles please refer to our sales representative.(For details, please see at the end of this manual.)

- Notations in this manual

Use the following marks in this manual.

Mark	Meaning of the icons
⚠**Danger**	Indicates that incorrect handling may result in death or severe injury, ignoring this marking.
⚠**Caution**	Indicates that incorrect handling may result in injury or property damage, ignoring this marking.
✓ **Supplement**	Indicates that precautions to avoid a malfunction and to work the unit properly.
☛	Indicates that the pages described that related matters.

- Checking package contents

This following items for this device and included in package. Check that no items are missing.
(1) Energy Measuring unit x1 (2) User's Manual (Digest) x1

> This unit cannot be used for deal and proof of electric energy measurement stipulated in the measurement law. Please use the certified watt-hour meter to be used for deal and proof of electric energy measurement stipulated.

Features

[EMU4-BD1-MB]

- This Energy Measuring unit can measure various types of electric quantity such as voltage, current, electric power and electric energy.
- The measured data can be sent to the high-end device, such as a monitoring device by MODBUS® RTU communication function.

[EMU4-HD1-MB]

- This Energy Measuring unit can measure various types of electric quantity such as voltage, current, electric power and electric energy.
- The measured data can be sent to the high-end device, such as a monitoring device by MODBUS® RTU communication function.
- This Energy Measuring unit has one external input terminal, which can switch between pulse input and contact input.
  Production quantity and water, gas, air (other than electricity) can be measured in the pulse input setting.
  Monitoring of condition and alarm, measurement of operating time and electric energy during operation can be done in the contact input setting.

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1. Precautions for Use

Precautions for Operating Environment and Conditions

- This unit is premised on being used in pollution degree 2* environment. When used in higher pollution degree, protect this unit from pollution on another device side to be incorporated.
- Over voltage category of measuring circuit in this unit is CAT II*, and that of auxiliary power circuit (MA, MB) is CAT II*.
- Do not use this product in the places listed below. Failure to follow the instruction may cause malfunctions and a life decrease of product.
  - Places the Ambient temperature exceeds the range -5 - +55°C.
  - Places the average daily temperature exceeds 35°C.
  - Places the Relative humidity exceeds the range 30-85% or places with dewfall.
  - Vibration and impact exceed the specifications.
  - Dust, corrosive gas, saline and oil smoke exist.
  - Places exposed to direct sunlight.
  - Places exposed to rain or water drop.
  - Places in strong electromagnetic field or places large amounts of external noise exist.
  - Places metal fragments or conductive substance are flying.
  - Altitude exceeds 1000m.

< For prevention of electric shock>

- This unit is designed to be housed within another device for prevention of electric shock. House this unit within the device such as the grounded control panel before use.
- To prevent persons with little knowledge about electric equipment from electric shock, panel must be taken either following measure.
  - Lock the panel so that only those who get an education about electric equipment and have sufficient knowledge can unlock, or shut off power supply automatically by opening the panel.
  - Cover the dangerous part of this unit. (Required protection code is higher than IP2X.)

*: For the definition of the pollution degree and the over voltage category, refer to EN61010-1/2010.

Matters concerning the precaution before use

- Use the unit in the specified usage environment and conditions.
- The setting of this unit (phase system, primary voltage, primary current, and sensor type) is necessary before use it.

Installation and Wiring Precautions

Make sure to read this manual carefully before Installation and Wiring.

⚠Caution

<Precautions for Electric work>

- Any person who is involved in the installation and the wiring of this unit should be fully competent to do this work.
- Work under the electric outage condition when installing and wiring. Failure to do so may cause electric shock, a failure of the unit, a fire etc.
- When tapping or wiring, take care not to entering any foreign objects such as chips and wire pieces into this unit.
- Check the connection diagram when wiring. Wrong wiring may cause failure of the unit, a fire or electric shock.
- For protection against noise, **transmission lines and input/output lines shall not be placed close to or bound together with the power lines and high-voltage lines**.
- The wires to be connected to this unit shall be placed in a duct or fixed together by cramping. If the electric wires are not placed in the duct or cramped together, loosen wires or their movement or careless stretch may cause a breakage of the unit or wire or a malfunction due to poor contact of electric wires.
- If transmission lines and input/output lines are placed close to or bound together with the power lines and high-voltage lines, keep distance as below between them.

Condition	Distance
Power line 600V or less Other power line	300mm or longer 600mm or longer

<Connection of terminal block>

- Strip the wires with proper length. Overlong stripping length may cause short to next wire. Shorter stripping length may cause contact failure.
- Take care not to short to next terminal by a filament. (Do not plate the wires with solder.)
- Do not connect three or more wires to one terminal of a terminal block for preventing loose contact and wires dropout.
- Use appropriate size of electric wires. If inappropriate size of electric wire is used, it may cause a fire due to generated heat.
- Circuits connected to a auxiliary power circuit (MA, MB) need to be used the over current protection device (fuse, circuit breaker, etc.) to prevent shorting connecting wires. (Select an appropriate rating to prevent burnout of the wires.)
- Tighten the screw within the specified torque. Over tightening can damage the screw and/or terminal.
- After tightening the screws, be sure to check all the screws tightened. Loose screw may cause malfunction of the unit, a fire or electric shock.
- Be sure to attach the terminal cover to prevent electric shock.
- Do not directly touch any conductive part of the unit. Doing so can cause electric shock, failure or malfunction of the unit.
- If the wires connected to this unit are strongly pulled off, it may cause a malfunction or a breakage to the unit or the wire.

<Connection with the current sensor>

- When using this product, make sure to use it in combination with current sensor (EMU-CT50 / CT100 / CT250 /CT400 /CT600, EMU2-CT5 and EMU2-CT5-4W). This product cannot connect with the secondary side (5A) of current transformer. Please not to exceed the rating of this product for input of current sensor. For further details, please refer to current sensor manual to maintain the functionality and the accuracy of this product.
- The dedicated current sensor (EMU-CT50/CT100/CT250/CT400/CT600) is used only for low voltage circuit. It cannot be used for a high voltage circuit. EMU2-CT5 and CT5-4W should be used with the secondary side (5A) of transformer transfixed. If it is connected with a high-voltage circuit by mistake, it may cause a burnout of the device and a fire. It is critically dangerous. For the allowable maximum voltage of current sensor, refer to “13. Option devices” “(1) Specifications” in this manual.
- The dedicated current sensor has a polarity (directionality). Be careful about it when installing the unit.

<Connection of frame GND terminal>

- Do not exceed the specified voltage when doing an insulation resistance test and a commercial frequency withstand voltage test. Do not connect to frame GND terminal during the insulation resistance test and pressure test.
- Use the crimp-type terminal appropriated for the size of electric wires. If inappropriate crimp-type terminal is used, a wire breakage or a contact failure may occur, which may cause a device malfunction, a failure, a burnout or a fire.
- Frame GND terminal must be grounded according to the D-type ground (ground resistance is not exceed 100Ω).

Precautions for Use

- **<u>This unit cannot be used for deal and proof of electric energy measurement stipulated in the measurement law.</u>**
- Before operating the product, check that active bare wire and so on does not exist around the product. If any bare wire exists, stop the operation immediately, and take an appropriate action such as isolation protection.
- In the event of a power outage during the setting, the unit is not set correctly. Please set again after power recovery.

⚠Danger

- Do not touch the live part. It may cause electric shock, electric burn injury or damage of the device.
- Work under the electric outage condition when installing and wiring.

⚠Caution

- Do not disassemble or modify this unit. It may cause failure, malfunction, injury or fire.
- Use this unit within the ratings specified in this manual. If it is used outside the ratings, it may cause not only malfunction or failure but also fire burnout.

Maintenance Precautions

- Use a soft dry cloth to clean off dirt of the unit surface. Do not let a chemical cloth remain on the surface for an extended period of time nor wipe the surface with thinner or benzene.
- Check for the following items to use this unit properly for long time.
  (1) Daily maintenance
    (a) No damage on this unit
    (b) No abnormality with LCD indicators
    (c) No abnormal noise, smell or heat
  (2) Periodical maintenance (Once every 6 months to 1 year)
    - No looseness with installation and wire connection

⚠Caution	Do periodical maintenance under the electric outage condition. Failure to do so may cause electric shock, failure of the unit or a fire. Tighten the terminal regularly to prevent a fire.

Storage Precautions

- To store this unit, turn off the power and remove wires, and put it in a plastic bag.
- For long-time storage, avoid the following places. Failure to follow the instruction may cause a failure and reduced life of the unit.
  - Places the Ambient temperature exceeds the range -10 - +60°C.
  - Places the average daily temperature exceeds 35°C.
  - Places the Relative humidity exceeds the range 30-85% or places with dewfall.
  - Vibration and impact exceed the specifications.
  - Dust, corrosive gas, saline and oil smoke exist.
  - Places metal fragments or conductive substance are flying.
  - Places exposed to rain, water drop or direct sunlight.

Disposal Precautions

When disposing of this unit, treat it as industrial waste.

About packaging materials and this manual

For reduction of environment load, packaging materials are produced with cardboard, and this manual is printed on recycled paper.

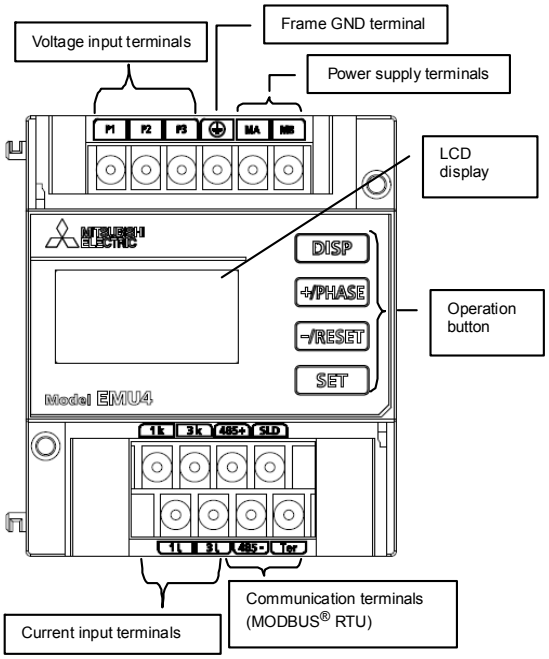
2. Disclaimer

- It is prohibited to reprint or copy all contents of this document in any form without our permission.
- The contents of this document will be updated to follow revisions to software and hardware, however under unavoidable circumstances it may not be synchronized.

3. Name and function of each part

· Name of each part

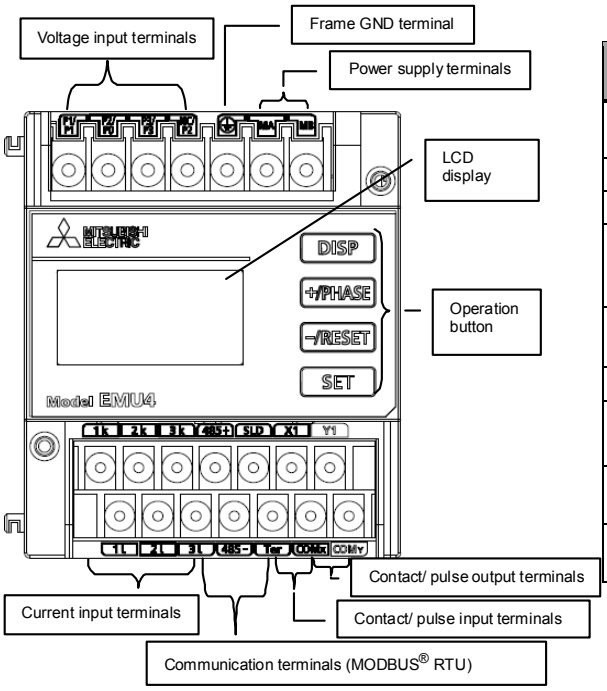
(1) EMU4-BD1-MB



Sign and function of the terminal block

Terminal symbols	Function	Description
P1, P2, P3	Input voltage	Connect the voltage input wire for the measuring circuit.
⏚	Frame GND (FG)	Connect to ground (D type ground).
MA, MB	Auxiliary power	Connect the auxiliary power supply.
1k, 1L, 3k, 3L	Input current	Connect the secondary output of the dedicated current sensor connected to the measurement circuit's current wire.
485+,485-	MODBUS® communication	Connect the communication wire (MODBUS® RTU).
SLD		Connect to ground (D type ground).
Ter		Connect with "485- "terminal (the unit at end of the link)☛P.11.

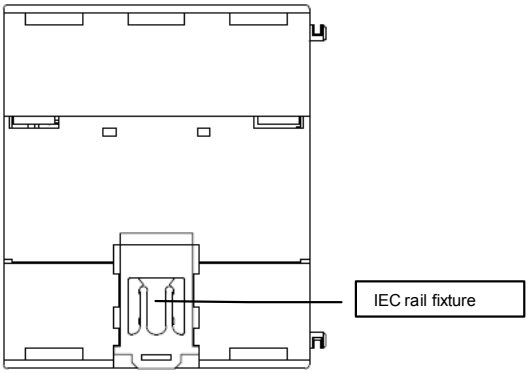
(2) EMU4-HD1-MB



Sign and function of the terminal block

Terminal symbols	Function	Description
P1/P1, P2/P0, P3/P3, NC/P2	Input voltage	Connect the voltage input wire of the measuring circuit.
⏚	Frame GND (FG)	Connect to ground. (D-type ground)
MA, MB	Auxiliary power	Connect the auxiliary power supply.
1k, 1L, 2k, 2L, 3k, 3L	Input current	Connect the secondary output of the dedicated current sensor connected to the measurement circuit's current wire.
485+, 485-	MODBUS® communication	Connect the communication wire (MODBUS® RTU).
SLD		Connect to ground. (D-type ground)
Ter		Connect with "485-" terminals (the unit at end of the link)☛P.11.
X1, COMx	Pulse input/ contact input	Connect pulse input/contact input wires.
Y1, COMy	Pulse output/ contact output	Connect pulse output/contact output wires.

· Back view



· Function of operation buttons

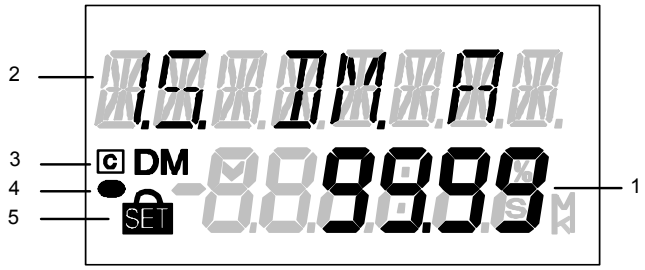
Control buttons have many functions as below. (How to change mode page 12.)

Meaning of symbol: ○ (Press), □ (Press more than 1 sec), ◎ (Press more than 2 sec), — (Press both at the same time)

DISP — DISP button
+/PHASE — +/PHASE button
-/RESET — -/RESET button
SET — SET button

Mode \ Operation		Name of Button SET	-/RESET	+/PHASE	DISP	Event
Operating Mode					○	Change measured items
				○		Change phase
			○			Change harmonic order (at harmonic display)
			◎			Clear alarm (at alarm generation display with alarm keeping)
		◎				Transition to confirmation mode
		◎	◎			Transition to setting mode
	Contact display		◎			Clear contact latch
	Integrated value display		◎	◎		Transition to preset display
		◎		◎		Transition to reset display of all data
Setting mode / Confirmation mode	Menu display	○				Enter setting menu
			○ (□)	○ (□)		Moving up or down of menu number (Move at fast speed when pressing more than 1sec)
	Setting mode / Setting display	○				Change of setting items (forward) Transition to setting menu number (at final setting item)
			○ (□)	○ (□)		Moving up or down of setting value (Move at fast speed when pressing more than 1sec)
					○	Change setting items (backward) Transition to setting menu number (at beginning setting item)
		□				Go back to setting menu
	Confirmation mode / Setting display	○				Change setting items (forward) Transition to setting menu number (at final setting item)
					○	Change setting items (backward) Transition to setting menu number (at beginning setting item)
		□				Transition to setting menu
	Confirmation display of setting reflection	○				At "END" display, memorize changed setting and transition to operating mode At "CANCEL" display, annul changed setting and transition to operating mode
			○	○		Moving up or down of setting value
			◎		◎	Reset setting values to factory default (only effective at CANCEL display)

· Functions of LCD



No.	Indicator	Description
1	Measured value	Display measured value digitally.
2	Measured item	Display measured item displayed on indicator 1.
3	Communication	Light when connecting communication unit.
4	Energy Measurement	Light when measuring electric energy
5	Setting	Indicator SET lights on setting mode. Indicator SET lights on confirmation mode.

4. Attaching and removing the unit

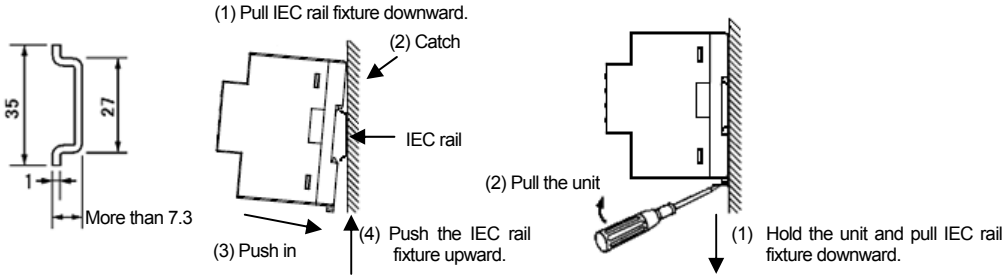
⚠Caution
Any person who is involved in the installation and the wiring of this unit should be fully competent to do this work.

There are two installation methods, surface mounting and panel mounting

· **Surface mounting**

(1) How to attach to the IEC rail

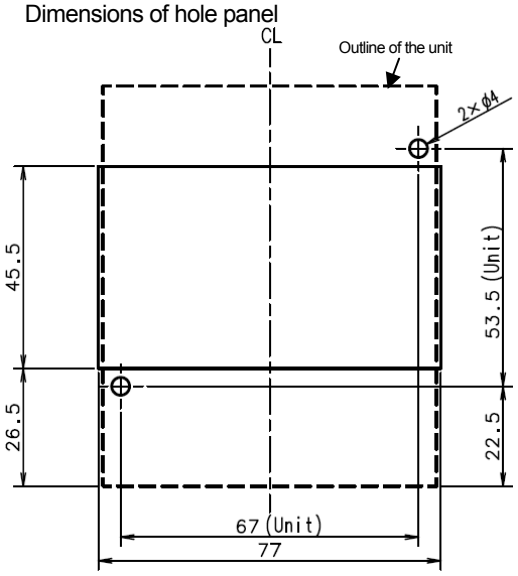
Applicable IEC rail Attaching Removing



· **Plate mounting**

(1) Screw mounting

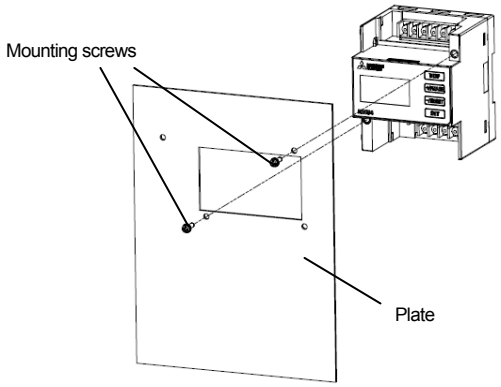
Dimensions of hole panel



Attaching

Attach the plate by using 2 screws.

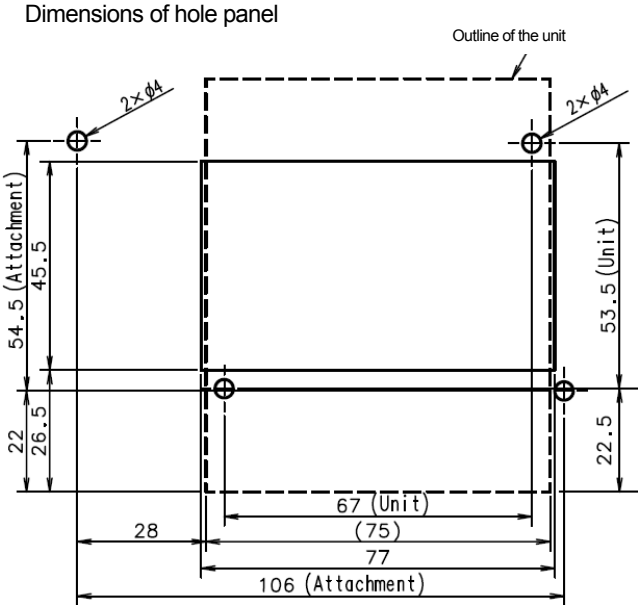
Tightening torque: 0.63N・m



Recommended screws	cross recessed head screw with captive washer and flat washer M3×10 2pcs

(2) Screw mounting (When using the attachment for panel mounting)

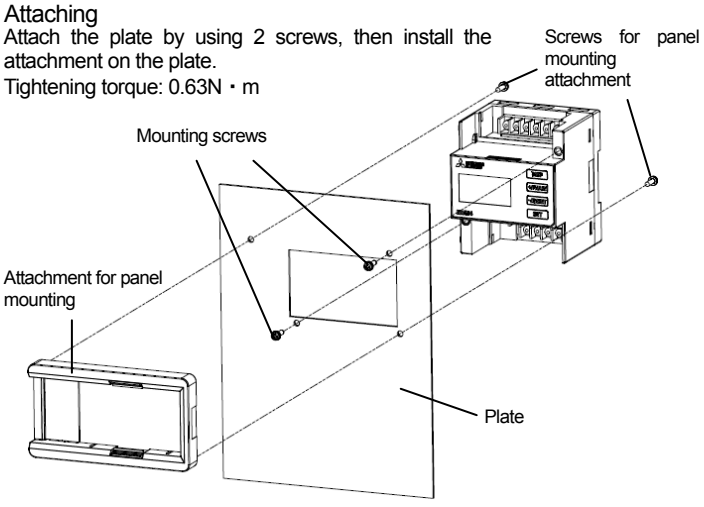
Dimensions of hole panel



Attaching

Attach the plate by using 2 screws, then install the attachment on the plate.

Tightening torque: 0.63N・m



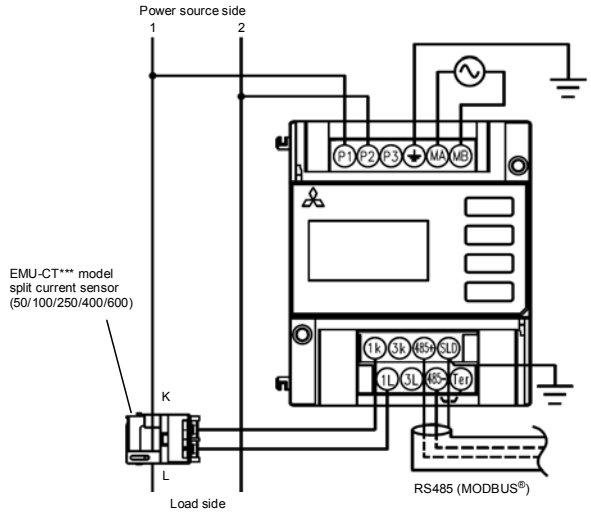
*Please screw up the panel mounting attachment where there are high levels of vibration.

*The screws (mounting screws and screws for panel mounting attachment) are supplied with panel mounting attachment.

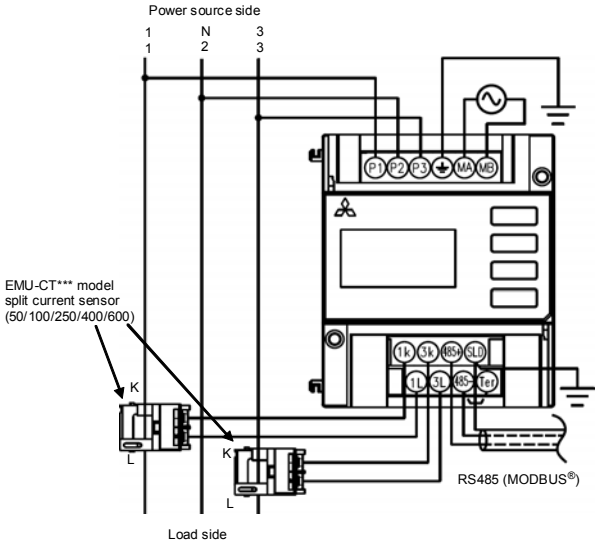
5. Procedure for wiring

Wiring for EMU4-BD1-MB

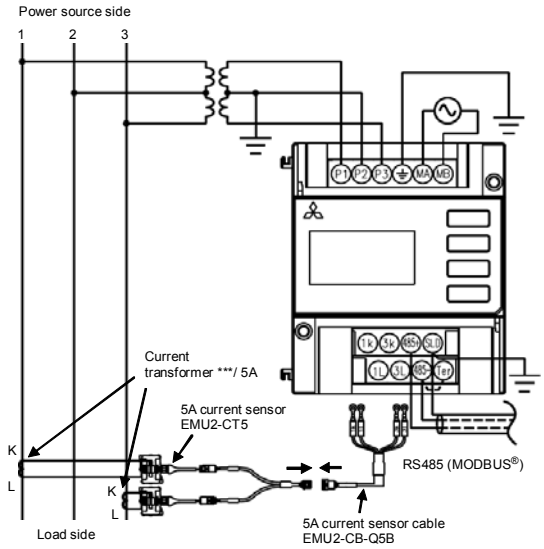
1P2W (for low voltage circuit)



1P3W/3P3W (for low voltage circuit)

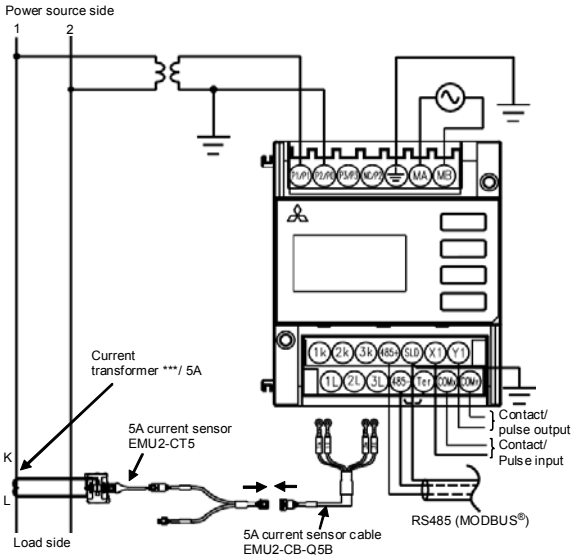


3P3W (for high voltage circuit)

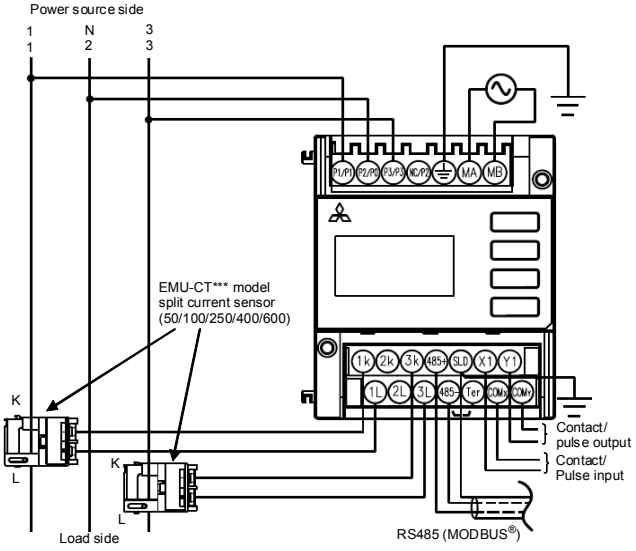


Wiring for EMU4-HD1-MB

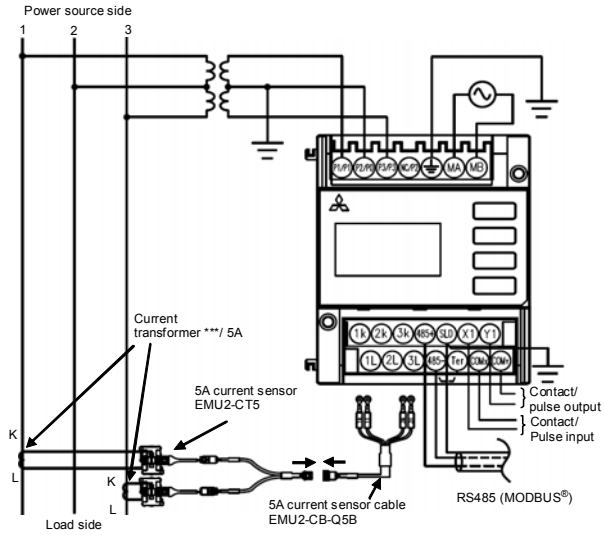
1P2W (for high voltage circuit)



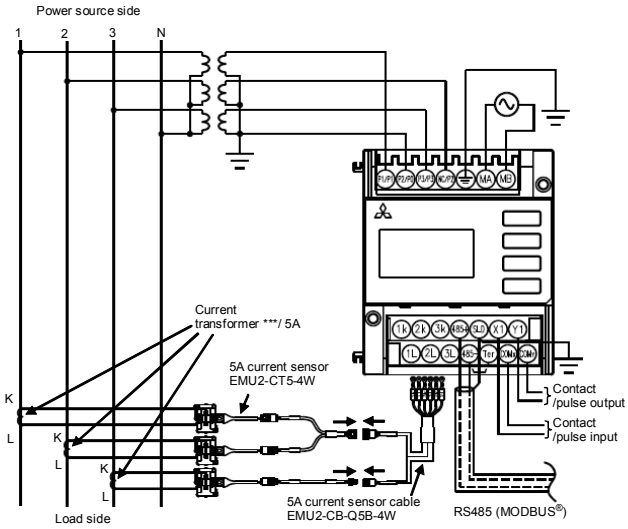
1P3W/3P3W (for low voltage circuit)



3P3W (for high voltage circuit)



3P4W (for high voltage circuit)



⚠Caution	・For protection against noise, transmission lines and input/output lines shall not be placed close to or bound together with the power lines and high-voltage lines. Keep distance as below between them. (except for the terminal block)

Condition	distance
Power line 600V or less	300mm or longer
Other power line	600mm or longer

・For the actual usage, connect the frame GND terminal to ground (D-type ground). Connect it directly to the ground terminal.
・Do not connect to frame GND terminal during the insulation resistance test and pressure test.

・Use appropriate crimp-type terminal. Appropriate crimp-type terminal is as below.
・Use electric wires as below, and tighten the terminal screws by the torque as below.

[EMU4-BD1-MB]

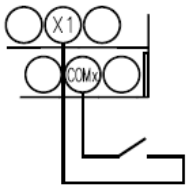
	Applicable wire	Tightening torque	Recommended crimp-type terminal
Auxiliary power, voltage input terminals	AWG24 - 16 (Single / Stranded)	0.8 N・m	For M3 screw of external diameter below 5.6mm
Current input, input and output terminals	AWG22 - 14 (Single / Stranded)	0.5～0.6N・m	For M3 screw of external diameter below 5.6mm

[EMU4-HD1-MB]

	Applicable wire	Tightening torque	Recommended crimp-type terminal
Auxiliary power, voltage input terminals	AWG26 - 14 (Single / Stranded)	0.8～1.0N・m	For M3.5 screw of external diameter below 5.6mm
Current input, input and output terminals	AWG22 - 14 (Single / Stranded)	0.5～0.6N・m	For M3 screw of external diameter below 5.6mm

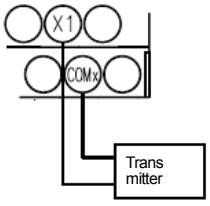
・Make sure that before connecting the cable, the orientation of the current sensor is correct for attachment. K to L is the correct direction. K: power source side, L: load side
・EMU-CT50/100/250/400/600 is used only for low voltage circuit. (Maximum voltage: 460V) It cannot be used for a high voltage circuit. EMU2-CT5 and EMU2-CT5-4W should be used with the secondary side (5A) of transformer transfixed. If they are used for the circuit directly, they should be used under 200V. (Maximum voltage: 260V)
・Maximum voltage of the circuit connected to this unit directly is 260V for EMU4-BD1-MB, or 277 / 480V for EMU4-HD1-MB. For the circuit over this voltage, use the transformer. Using the transformer, primary voltage is configurable up to 6600V.
・For MODBUS® communication wiring, recommended to have the extra length wires about 200mm (When extended to B / NET transmission from MODBUS® communication, use of MODBUS® communication wiring is possible).
・When screwing the terminals at both ends of the terminal block, be careful not to touch the projection of the terminal block cover.
・In case using external input and/or external output, refer to the following.

External input：For the case of contact input



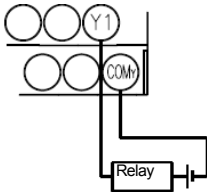
No-voltage a-contact
Use an appropriate type for 5V DC 7mA switching.

External input: For the case of pulse input



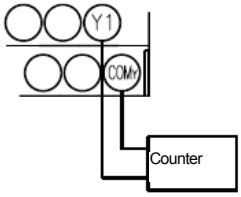
No-voltage a-contact
Use an appropriate type for 5V DC 7mA switching.

External output：For the case of contact output



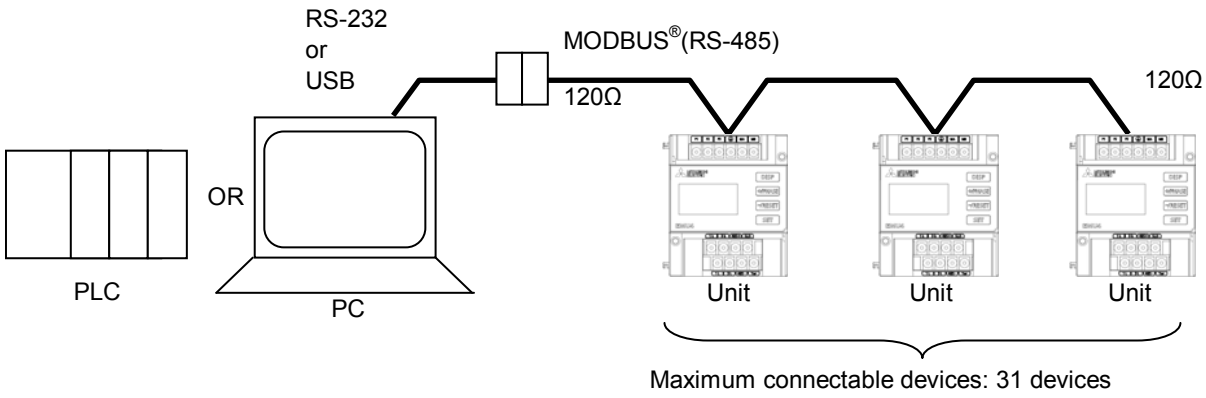
No-voltage a-contact
35V DC 75mA or,
24V AC 75mA (power factor : 1)

External output: For the case of pulse output



No-voltage a-contact
35V DC 75mA or,
24V AC 75mA (power factor : 1)

・ System configuration example of MODBUS® communication



・Connection of MODBUS® communication terminals:

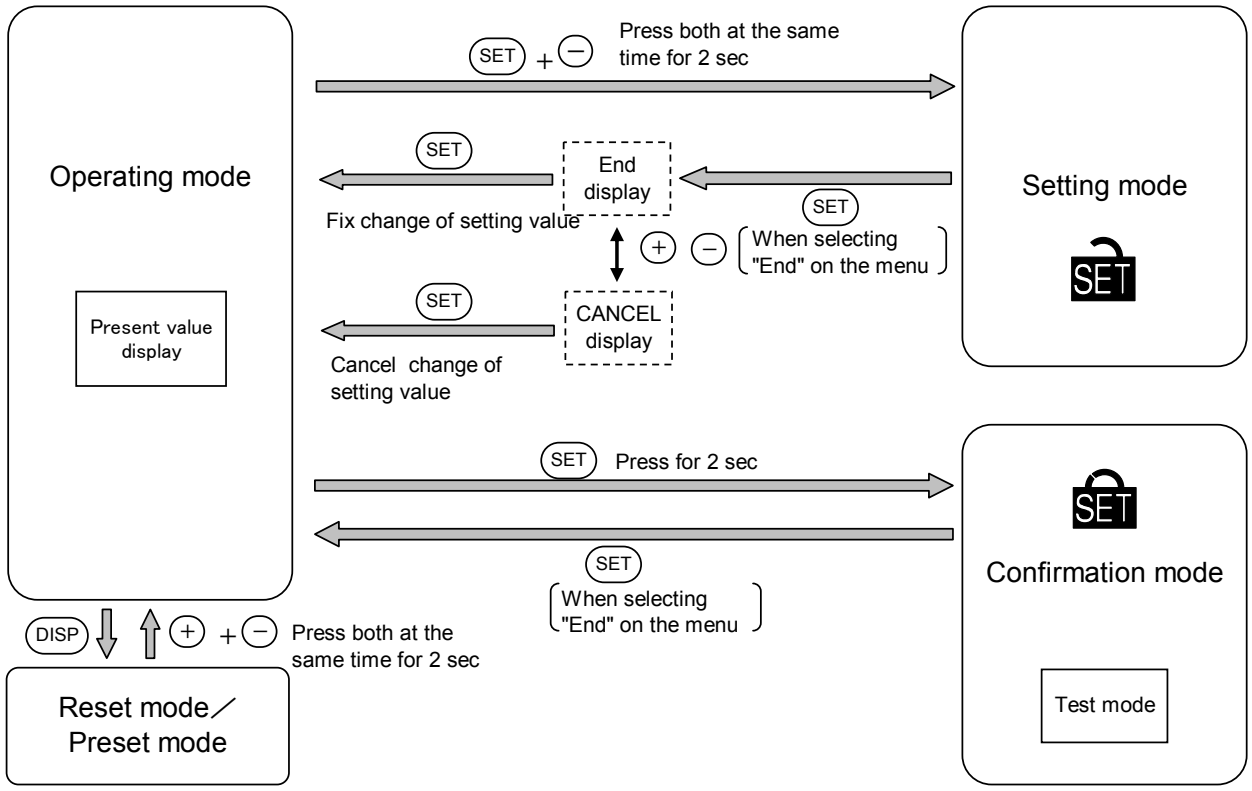
1. Use the twisted shielded pair cable for transmission lines.(Recommended cable ☛page 62.)
2. Connect the termination resistances (120Ω) to both ends of the devices connected the MODBUS® transmission line. Termination resistances of 120Ω can be used by short-circuiting “485-” and “Ter” terminals.
3. Connect to ground by using thick wires to decrease impedance.
4. MODBUS® transmission lines shall not be placed close to or bound together with the high-voltage lines.
5. Ground the “SLD” terminal at one end.

6. Operating mode

This unit has the operating modes. Switch these modes according to the purposes. The operating mode is displayed immediately after the auxiliary power loading.

Mode	Function	Reference
Operating mode	Display measured value digitally. It can display the condition of contact input (*1) and present time (*2) other than the present value of the measured values.	page 44
Setting mode	Set basic setting for phase wire method, primary voltage, primary current, and sensor type and alarm monitoring for alarm output elements.	page 13
Confirmation mode	Mode to confirm the setting value for each setting item. (The Setting cannot be changed in this mode, so it can be prevented setting change by human error.) In addition, this unit has the test function that can be used for such as set up of an equipment. ・ Discrimination support display for incorrect wiring: Display useful to discriminate for incorrect wiring such as phase angle display of voltage, current. ・ Pulse, Alarm test: Switch pulse output contact and alarm contact without measurement (voltage and current) input. ・ Communication test: Send back fixed numerical data without measurement (voltage and current) input.	page 25 page 29
Reset mode / Preset mode	Reset: Integrated values (electric energy, operating time, etc.) can be zeroed. Preset: Preset of electric energy and reactive energy.	page 52

*1: EMU4-HD1-MB only.
*2: Only when connecting logging unit.



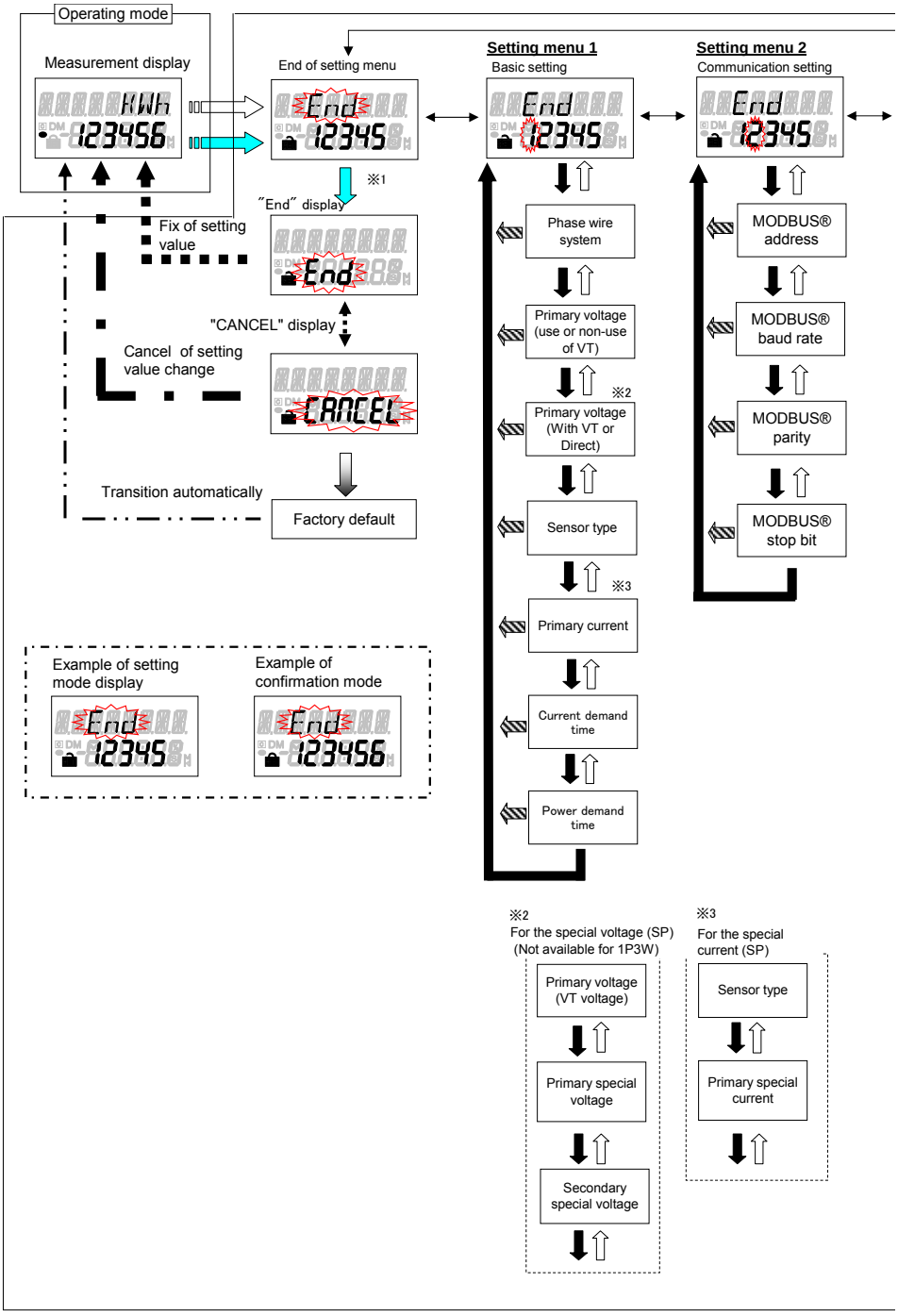
7. Setting method

Procedures for setting

Set items such as phase wire system, primary voltage, and primary current in the setting mode to measure and monitor.
Under normal use, it shall be sufficient to set the setting menu 1 (Basic setting) only.
For details, refer to after the following page.

<How to set>

(1) Go into the setting mode by pressing both [SET] and [- / RESET] at the same time for 2 sec.
(2) Determine the setting menu number by pressing [+ / PHASE] or [- / RESET].
(3) Determine the setting menu number by pressing [SET].
(4) Set each setting item.
(5) After all setting are done, select “End” on the setting menu and press [SET].
(6) When prompted for End display, select “End” and press [SET].

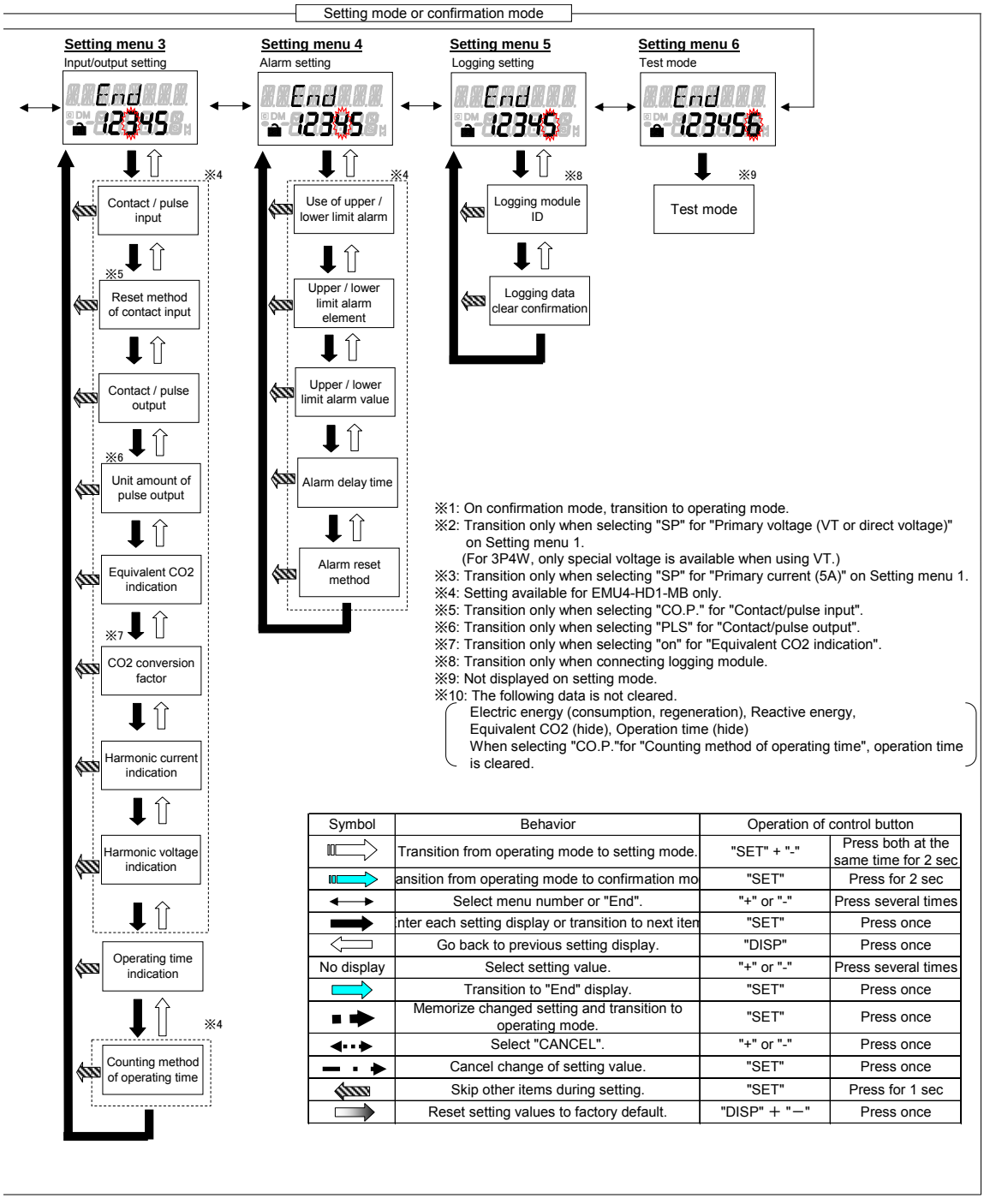


⚠Caution	If you change setting, related setting items and measured data are initialized. Check page 26 before change.

Procedures for setting

・ Basic operations in setting

Function	Operation	Supplement
Choose setting value	Press [+ / PHASE] or [- / RESET].	Press for more than one second to fast-forward
confirm setting value	Press [SET].	After setting value is confirmed, transition to next item.
Go back the previous setting item	Press [DISP].	Setting value of the last item before return is effective.
Go back to setting menu during setting	Press [SET] for one second.	



※1: On confirmation mode, transition to operating mode.
※2: Transition only when selecting "SP" for "Primary voltage (VT or direct voltage)" on Setting menu 1.
(For 3P4W, only special voltage is available when using VT.)
※3: Transition only when selecting "SP" for "Primary current (5A)" on Setting menu 1.
※4: Setting available for EMU4-HD1-MB only.
※5: Transition only when selecting "CO.P." for "Contact/pulse input".
※6: Transition only when selecting "PLS" for "Contact/pulse output".
※7: Transition only when selecting "on" for "Equivalent CO2 indication".
※8: Transition only when connecting logging module.
※9: Not displayed on setting mode.
※10: The following data is not cleared.
Electric energy (consumption, regeneration), Reactive energy, Equivalent CO2 (hide), Operation time (hide)
When selecting "CO.P."for "Counting method of operating time", operation time is cleared.

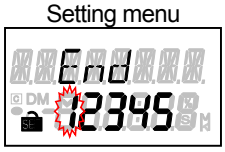
Symbol	Behavior	Operation of control button	
	Transition from operating mode to setting mode.	"SET" + "-"	Press both at the same time for 2 sec
	ansition from operating mode to confirmation mo	"SET"	Press for 2 sec
	Select menu number or "End".	"+" or "-"	Press several times
	nter each setting display or transition to next iten	"SET"	Press once
	Go back to previous setting display.	"DISP"	Press once
No display	Select setting value.	"+" or "-"	Press several times
	Transition to "End" display.	"SET"	Press once
	Memorize changed setting and transition to operating mode.	"SET"	Press once
	Select "CANCEL".	"+" or "-"	Press once
	Cancel change of setting value.	"SET"	Press once
	Skip other items during setting.	"SET"	Press for 1 sec
	Reset setting values to factory default.	"DISP" ＋ "－"	Press once

Setting menu 1: Phase wire system, primary voltage, sensor type, primary current, demand time, etc.

In this menu, set phase wire system, primary voltage, sensor type, primary current, demand time, etc.

In operating mode, press both [SET] and [- / RESET] at the same time for more than two seconds to transition to setting mode and enable the following operations.

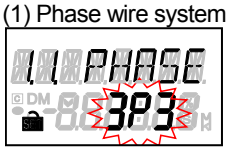
Setting menu



Choose the setting menu 1.
(As shown in the left figure)

[SET] [DISP]

(1) Phase wire system



Set according to the phase wire system for the measured circuit.

- For EMU4-BD1-MB

<u>3P3: Three-phase 3-wire</u>
1P2: Single-phase 2-wire
1P3: Single-phase 3-wire

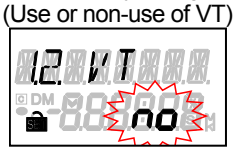
- For EMU4-HD1-MB

<u>3P3: Three-phase 3-wire</u>
3P4: Three-phase 4-wire
1P2: Single-phase 2-wire
1P3: Single-phase 3-wire

Supplement: The underlined values are the defaults. (The same shall apply hereinafter.)

[SET] [DISP]

(2) Primary voltage
(Use or non-use of VT)



If you measure directly (i.e. without VT):
→Choose “no” and press [SET] to transition to (3) Primary voltage (Direct).
If you measure with VT:
→Choose “yES” and press [SET] to transition to (4) Primary voltage (VT).

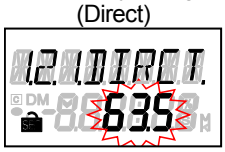
<u>no</u> ↔ yES

Supplement:
“VT” means Voltage Transformer.

<In case you choose “1P3” in (1) Phase wire system>
You can use direct measurement only.
Setting of primary voltage is skipped and setting is started from (7) Sensor type.
Rated voltage between 1- and 2-phase and 2- and 3-phase is 110V, and that between 1- and 3-phase is 220V.

[SET] [DISP]

(3) Primary voltage
(Direct)



Set the direct voltage according to voltage of the measured circuit

- For EMU4-BD1-MB

110V ↔ <u>220V</u>

- For EMU4-HD1-MB

(In case you choose “3P3” or “1P2” in (1) Phase wire system)

→ 110V ↔ <u>220V</u> ↔ 440V ←

(In case you choose “3P4” in (1) Phase wire system)

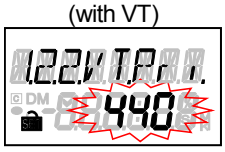
→ 63.5V/110V
100V/173V
105V/182V
110V/190V
115V/199V
120V/208V
127V/220V
200V/346V

<u>220V/380V</u>
230V/400V
240V/415V
242V/420V
250V/430V
254V/440V
265V/460V
277V/480V

[SET] [DISP]

Setting menu 1: Phase wire system, primary voltage, sensor type, primary current, demand time, etc.

(4) Primary voltage (with VT)



SET

DISP

Set the primary voltage of combined VT

・ For EMU4-BD1-MB

440V ↔ 690V ↔ 1100V ↔ 2200V ↔ 3300V ↔ 6600V ↔ SP

・ For EMU4-HD1-MB

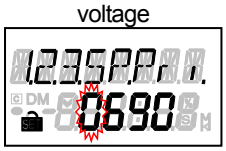
690V ↔ 1100V ↔ 2200V ↔ 3300V ↔ 6600V ↔ SP

Caution:
If there is no values above you want to set to, choose “SP” to enable the special primary voltage and the special secondary voltage.
In case you choose “3P4” (three-phase 4-wire system) in (1) Phase wire system, the special voltage is only available.

If you choose “SP”, transition to “(5) Special primary voltage”.

If you choose the value except for “SP”, transition to “(7) Sensor type”.
(In this case, secondary voltage is fixed to 110V.)

(5) Special primary voltage



SET

DISP

Set the special primary voltage of combined VT.

・ Setting range: 1V to 6600V

Default value is 440V (for EMU4-BD1-MB), or 690V (for EMU4-HD1-MB).

Setting of special primary voltage

- Press + / PHASE or - / RESET to choose the value at flashing digit.
- Press SET for the setting digit (flashing digit) to shift to lower.
- Press DISP for the setting digit (flashing digit) to shift to upper.
- You can set the upper three digit of the value to the range of 1V to 6600V.
  Caution: In case you set the value except for between 1V and 6600V, indicate the error (E005). When indicating the error, press SET to check the setting values and set the new value again.
- Press SET at the lowest digit to transition to “(6) Special secondary voltage”.
  The values set the upper fourth digit and lowers to are rounded down. After setting value flashes three times, transition to “(6) Special secondary voltage”.

SET

DISP

(6) Special secondary voltage

SET

DISP

Set the special secondary voltage of combined VT.

・ Setting range: 1V to 220V

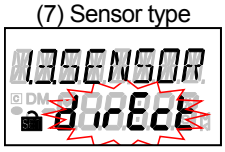
Default value is 110V (for three phase 3-wire system and single-phase 2-wire system), or 64V (for three-phase 4-wire system).

Setting of special secondary voltage

- Press + / PHASE or - / RESET to choose the value at flashing digit.
- Press SET for the setting digit (flashing digit) to shift to lower.
- Press DISP for the setting digit (flashing digit) to shift to upper.
- You can set the value to the range of 1V to 220V.
  Caution: In case you set the value except for between 1V and 220V, indicate the error (E005). When indicating the error, press SET to check the setting values and set the new value again.
- Press SET at the lowest digit to transition to “(7) Sensor type”.

Setting menu 1: Phase wire system, primary voltage, sensor type, primary current, demand time, etc.

(7) Sensor type

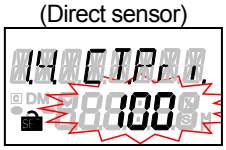


Set the type of combined current sensor.
If you use direct sensor,
choose “dirEct” and press [SET] to transition to “(8) Primary current (Direct)”.
If you use 5A sensor,
choose “5A” and press [SET] to transition to “(9) Primary current (5A sensor)”.

dirEct ⟷ 5A

[SET] [DISP]

(8) Primary current (Direct sensor)



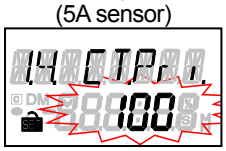
Set the primary current of combined CT (for direct sensor).

50A ⟷ 100A ⟷ 250A ⟷ 400A ⟷ 600A

After you choose the value, transition to “(11) Current demand time”.

[SET] [DISP]

(9) Primary current (5A sensor)



Set the primary current of combined CT (for 5A sensor).

5A	40A	250A	1250A
6A	50A	300A	1500A
7.5A	60A	400A	1600A
8A	75A	500A	2000A
10A	80A	600A	2500A
12A	100A	750A	3000A
15A	120A	800A	4000A
20A	150A	1000A	5000A
25A	200A	1200A	6000A
30A			SP

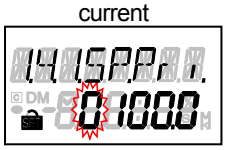
Supplement: If there is no values above you want to set to, choose “SP” to enable the special primary current.

If you choose “SP”, transition to “(10) Special primary current”.

If you choose the value except for “SP”, transition to “(11) Current demand time”.

[SET] [DISP]

(10) Special primary current



Set the special primary current of combined CT.

- Setting range: 5A to 6000A (Default: 100.0A)

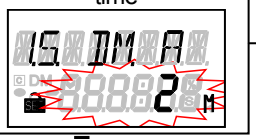
Setting of special primary current

- Press [+ / PHASE] or [- / RESET] to choose the value at flashing digit.
- Press [SET] for the setting digit (flashing digit) to shift to lower.
- Press [DISP] for the setting digit (flashing digit) to shift to upper.
- You can set the value in the range from 5A to 6000A.
  If the value is less than 10A, you can set upper two digits of it.
  If the value is 10A or more, you can set upper three digits of it.
  Caution: In case you set the value except for the range from 5A and 6000A, indicate the error (E005). When indicating the error, press [SET] to check the setting values and set the new value again.
- Press [SET] at the lowest digit to transition to “(11) Current demand time”.

[SET] [DISP]

Setting menu 1: Phase wire system, primary voltage, sensor type, primary current, demand time, etc.

(11) Current demand time



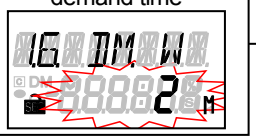
SET

DISP

Set the current demand time.
On setting display, “s” means “second” and “M” means “minute”.

0s	40s	3M	7M	11M	15M
10s	50s	4M	8M	12M	20M
20s	1M	5M	9M	13M	25M
30s	2M	6M	10M	14M	30M

(12) Electric power demand time



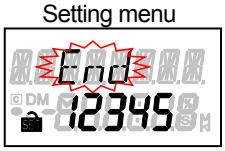
SET

DISP

Set the electric power demand time.
On setting display, “s” means “second” and “M” means “minute”.

0s	40s	3M	7M	11M	15M
10s	50s	4M	8M	12M	20M
20s	1M	5M	9M	13M	25M
30s	2M	6M	10M	14M	30M

Setting menu



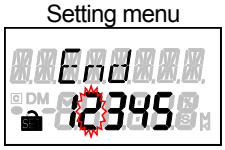
Complete the setting or continue in other menu according to procedures for setting.

For procedures for setting, ☛page 13.

Setting menu 2: MODBUS® communication

In this menu, set address, baud rate, parity and stop bit for MODBUS® communication.
In operating mode, press both [SET] and [- / RESET] at the same time for more than two seconds to transition to setting mode and enable the following operations.

Setting menu



Choose the setting menu 2.
(As shown in the left figure)

[SET] [DISP]

(1) Address for MODBUS®

Set the address for MODBUS®
・ Available address: 1 to 255

[SET] [DISP]

(2) Baud rate for MODBUS®

Set the transmission speed for MODBUS®

2400bps ↔ 4800bps ↔ 9600bps ↔ 19200bps ↔ 38400bps

[SET] [DISP]

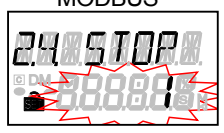
(3) Parity for MODBUS®

Set the Parity for MODBUS®

EVEn ↔ non ↔ odd

[SET] [DISP]

(4) Stop bit for MODBUS®



Set the stop bit for MODBUS®

1 ↔ 2

[SET] [DISP]

Setting menu

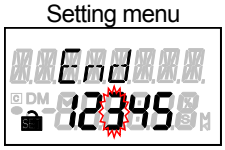
Complete the setting or continue in other menu according to procedures for setting.

For procedures for setting, ☛page 13.

Setting menu 3: Contact / pulse input/output, equivalent CO_2, harmonic, operating time, etc.

In this menu, set contact / pulse input/output, equivalent CO_2, harmonic, operating time, etc.
In operating mode, press both [SET] and [- / RESET] at the same time for more than two seconds to transition to setting mode and enable the following operations.

Setting menu

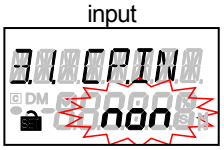


Choose the setting menu 3.
(As shown in the left figure)

- For EMU4-BD1-MB, choose "3" and press [SET] to transition to [(9) Operating time indication].
- For EMU4-HD1-MB, choose "3" and press [SET] to transition to the setting below.

[SET] [DISP]

(1) Contact / pulse input



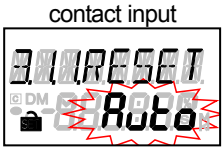
Set External input signal.

non ↔ PLS. ↔ CO.P.

For pulse input, choose "PLS.".
For contact input, choose "CO.P.".
In case you do not set it, choose "non".

[SET] [DISP]

(2) Reset method of contact input



Set the reset method of contact input.

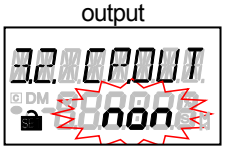
Auto ↔ HoLd

Reset method (Setting value)	Summery
Auto-reset (Auto)	When contact input turns OFF (open), contact input state also turns OFF (open) automatically.
Self-retention (HoLd)	Once the device detects contact input ON (close), contact input state keeps ON (close) until retention clear operation even if contact input turns OFF (open).

Supplement: In [(1) Contact / pulse input], when you choose the value except for "CO.P.", this setting is skipped.

[SET] [DISP]

(3) Contact / pulse output



Set External output signal.

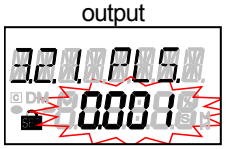
non ↔ PLS. ↔ CO.P.

For pulse output, choose "PLS.".
For contact output, choose "CO.P.".
In case you do not set it, choose "non".

[SET] [DISP]

Setting menu 3: Contact / pulse input/output, equivalent CO_2, harmonic, operating time, etc.

(4) Unit amount of pulse output



SET DISP

Set the unit amount per pulse of pulse output.
Selectable unit amount is as follows depending on the full load power:

$$\text{Full load power [kW]} = \frac{\alpha \times (\text{VT primary voltage}) \times (\text{CT primary current})}{1000}$$

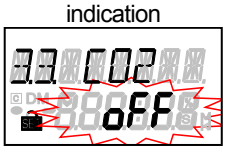
α: 1 Single-phase, 2-wire
2 Single-phase, 3-wire
√3 Three-phase, 3-wire
3 Three-phase, 4-wire

*1: VT primary voltage in single-phase 3-wire system is regarded as 110V.
*2: Using direct connection, replace VT primary voltage with direct voltage in calculation above.
*3: In three-phase 4-wire system, replace VT primary voltage or direct voltage with phase voltage in calculation above.

Full load power [kW]			Selectable unit amount per pulse [kWh/pulse]				Default value
		less than 12	1	0.1	0.01	0.001	0.001
12 or more	and	less than 120	10	1	0.1	0.01	0.01
120 or more	and	less than 1200	100	10	1	0.1	0.1
1200 or more	and	less than 12000	1000	100	10	1	1
12000 or more	and	less than 120000	10000	1000	100	10	10
120000 or more			100000	10000	1000	100	100

Supplement: In (3) Contact / pulse output, when you choose the value except for "PLS.", this setting is skipped.

(5) Equivalent CO_2 indication



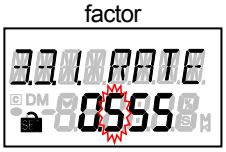
SET DISP

Set whether the equivalent CO_2 is indicated or not.

oFF ↔ on
(Do not indicate) (Indicate)

- If you need this indication, choose "on" and press SET to transition to the setting below.
- If you do not need this indication, choose "oFF" and press SET to transition to (7) Harmonic current indication.

(6) CO_2 conversion factor



SET DISP

Set the CO_2 conversion factor
(Default value: 0.555kg - CO_2 / kWh)

Setting of CO_2 conversion factor

- Press + / PHASE or - / RESET to choose the value at flashing digit.
- Press SET for the setting digit (flashing digit) to shift to lower.
- Press DISP for the setting digit (flashing digit) to shift to upper.
- You can set the value to the range of 0.000 to 0.999 (kg - CO2 / kWh).
- Press SET at the lowest digit to transition to (7) Harmonic current indication.

(7) Harmonic current indication

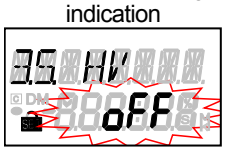
SET DISP

Set whether the harmonic current is indicated or not.

oFF ↔ on
(Do not indicate) (Indicate)

Setting menu 3: Contact / pulse input/output, equivalent CO_2, harmonic, operating time, etc.

(8) Harmonic voltage indication

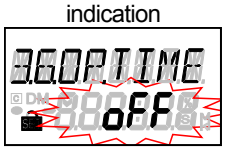


SET / DISP

Set whether the harmonic voltage is indicated or not.

oFF (Do not indicate) ↔ on (Indicate)

(9) Operating time indication



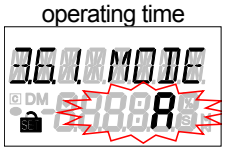
SET / DISP

Set whether the operating time is indicated or not.
(Operating time is integrated while this setting is “oFF”.)

oFF (Do not indicate) ↔ on (Indicate)

- For EMU4-BD1-MB, choose “oFF” or “on” and press SET to transition to setting menu.
- For EMU4-HD1-MB, choose “oFF” or “on” and press SET to transition to the setting below.

(10) Counting method of operating time



SET / DISP

Set the counting method of operating time.

A (By current) ↔ CO.P. (By contact input)

Setting menu

Complete the setting or continue in other menu according to procedures for setting.

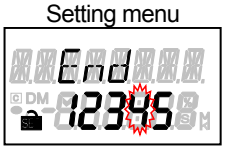
For procedures for setting, ☛page 13.

Setting menu 4: Upper / lower limit alarm setting, alarm delay time ,alarm reset, etc.

In this menu, set the upper / lower alarm, alarm delay time, reset method of alarm clear, etc.

In operating mode, press both [SET] and [- / RESET] at the same time for more than two seconds to transition to setting mode and enable the following operations.

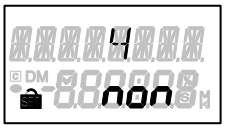
Setting menu



[SET] [DISP]

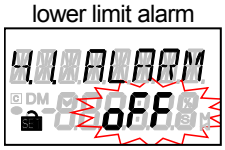
Choose the setting menu No. 4.
(As shown in the left figure)

Caution: For EMU4-BD1-MB, there is no function of setting menu 4, so the display indicates “non” (as shown in the right figure) and go back to setting menu display.



(“non” indication)

(1) Use of upper / lower limit alarm



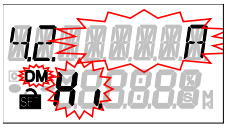
Set the use or non-use of upper / lower limit alarm.

oFF (Do not use alarm) ↔ on (Use alarm)

- If you do not use alarm, choose “oFF” and press [SET] to enter setting menu.
- If you use alarm, choose “on” and press [SET] to transition to the setting below.

[SET] [DISP]

(2) Upper / lower limit alarm element



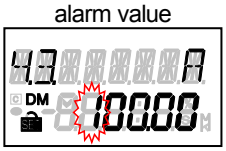
Set the measured element applying upper / lower limit alarm to.
Upper / lower limit alarm of measured value is available by setting this item.

DA upper limit	DW upper limit
DA lower limit	DW lower limit
DA (N) upper limit	PF upper limit
V (L-L) upper limit	PF lower limit
V (L-L) lower limit	PULSE upper limit
V (L-N) upper limit	
V (L-N) lower limit	

Caution:
1. DA: Current demand, DA(N): N-phase current demand, DW: Electric power demand
   V (L-L) : Line voltage, V (L-N) : Phase voltage
2. “DA (N)” and “V (L-N)” are selectable in three-phase 4-wire system
3. “PULSE” is only selectable when you choose “Pulse (PLS.)” on (1) Contact / pulse input of setting menu No.3.

[SET] [DISP]

(3) Upper / lower limit alarm value



Set the alarm value of upper / lower limit alarm element.
Setting range is as follows:

Measured element	Setting range	Unit
DA upper limit, DA (N) upper limit	0 - 100 (%) of primary current	A
DA lower limit	0 - 100 (%) of primary current	A
V (L-L) upper limit, V (L-N) upper limit	0 - 100 (%) of primary voltage	V
V (L-L) lower limit, V (L-N) lower limit	0 - 100 (%) of primary voltage	V
DW upper limit	-100 - 0 - 100 (%) of full load power	W
DW lower limit	-100 - 0 - 100 (%) of full load power	W
PF upper limit	-50 - 100 - 50 (%)	%
PF lower limit	-50 - 100 - 50 (%)	%
PULSE upper limit	1 – 999999 (Default value is 100000)	

For operation of alarm value setting, refer to next section.

[SET] [DISP]

Setting menu 4: Upper / lower limit alarm setting, alarm delay time ,alarm reset, etc.

Operations in alarm value setting display are as follows:

Setting of "Upper / lower limit alarm value"

- Press [+ / PHASE] or [- / RESET] to choose the value at flashing digit.
- Press [SET] for the setting digit (flashing digit) to shift to lower.
- Press [DISP] for the setting digit (flashing digit) to shift to upper.
- Setting range is different for each alarm element. (refer to previous section)
  Caution: In case the value is set to outside-set-value, indicate the error (E005)
  When indicating the error, press [SET] to check the setting values and set the new value again.
- Press [SET] at the lowest digit to transition to [(4) Alarm delay time].

(4) Alarm delay time

Set the delay time from fulfilling alarm occurring condition.

Set the alarm delay time if you want to avoid the alarm caused by such as instant overload and noise.
Once setting, the alarm does not occur unless the time of exceeding the upper / lower limit alarm value is over the specified delay time.

In setting display, "s" means "second" and "M" means "minute".

0s	30s	2M
5s	40s	3M
10s	50s	4M
20s	1M	5M
	50s	4M

[SET] [DISP]

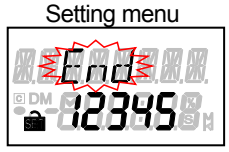
(5) Alarm reset method

Set the alarm reset method in alarm occurrence.

Alarm reset method (Setting value)	Summery (For details, refer to page 42)
Auto-reset (Auto)	Reset the alarm automatically when alarm occurring condition is gone.
Self-retention (HoLd)	The alarm is held even after alarm occurring condition is gone. Button operation is necessary to clear the alarm.

[SET] [DISP]

Setting menu



Complete the setting or continue in other menu according to procedures for setting.

For procedures for setting, ☛page 13.

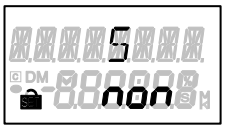
Setting menu 5: Setting related to logging unit

In this menu, set the logging unit ID or logging data clear.

In operating mode, press both [SET] and [- / RESET] at the same time for more than two seconds to transition to setting mode and enable the following operations.

Setting menu

Choose the setting menu 5
(As shown in the left figure.)

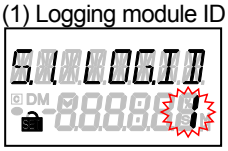


("non" indication)

Caution: When the logging module is not connected, the display indicates "non" (as shown in the right figure) and go back to setting menu

[SET] [DISP]

(1) Logging module ID

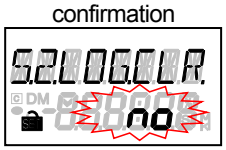


Set the basic measuring unit number memorized in the logging unit.

・Available ID: 1 to 255

[SET] [DISP]

(2) Logging data clear confirmation

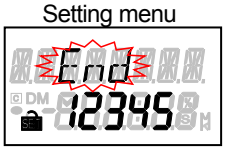


Clear the logging data.

no ⟷ yES
(Do not clear data) (Clear data)

[SET] [DISP]

Setting menu



Complete the setting or continue in other menu according to procedures for setting.

For procedures for setting, ☛page 13.

Confirmation menu 1 - 5: Confirmation of setting values in setting menu 1 - 5

In operating mode, press [SET] for more than two seconds to transition to confirmation mode and enable operation. Transition of display and operation is as same as those of setting menu 1 - 5.
For setting menu 1 - 5, ☛pp.15 - 25

(Caution: Change of setting is not available in confirmation mode.)

Initialization of related items by change of setting

Initialized item		Setting item	Changed setting value: Menu 1 — Phase wire system	Use of VT	Direct voltage	Primary voltage (Special primary voltage)	Secondary voltage	Sensor type	Primary current (Special primary current)	Electric power demand time	Current demand time	Menu 2 — Modbus address	Modbus baud rate	Modbus parity	Modbus stop bit	Menu 3 — Contact/pulse input	Contact reset status	Contact/pulse output	Pulse output unit	With or without CO2 indication	Equivalent CO2 setting	Harmonic current indication setting	Harmonic voltage indication setting	Operating time indication setting	Operating time measured item setting	Menu 4 — Use of upper/lower limit alarm	Upper/lower limit alarm element	Upper/lower limit alarm value	Alarm delay time	Alarm reset method	Menu 5 — Logging ID	Logging date clear confirmation
Menu 1		Phase wire system																													
		Use of VT	●																												
		Direct voltage	●																												
		Primary voltage (Special primary voltage)	●																												
		Secondary voltage	●																												
		Sensor type	○																												
		Primary current (Special primary current)	○					○																							
		Electric power demand time																													
		Current demand time																													
Menu 2		Modbus address																													
		Modbus baud rate																													
		Modbus parity																													
		Modbus stop bit																													
Menu 3		Contact/pulse input																													
		Contact reset status																													
		Contact/pulse output																													
		Pulse output unit																													
		With or without CO2 indication																													
		Equivalent CO2 setting																													
		Harmonic current indication setting																													
		Harmonic voltage indication setting																													
		Operating time indication setting																													
		Operating time measured item setting																													
Menu 4		Use of upper/lower limit alarm	○	○	○	○	○	○	○							□															
		Upper/lower limit alarm element	○	○	○	○	○	○	○							□															
		Upper/lower limit alarm value	○	○	○	○	○	○	○							□										○					
		Alarm delay time																													
		Alarm reset method																													
Menu 5		Logging ID																													
		Logging date clear confirmation																													

Symbol	Meaning
○	Initialized
●	Change to default value corresponding to phase wire system
□	Initialized when the upper limit of pulse count is set and input method is changed from pulse to contact.
None	Not initialized

All settings are reset to factory default by the following operation.
Settings are only initialized. Integrated values (such as electric energy, reactive energy and operating time) are not changed.

Enter CANCEL display in setting mode and operate as follows to initialize all settings.
For entering CANCEL display, refer to procedures for setting. (☛page 13)

Setting mode

CANCEL display

Press both DISP and - / RESET at the same time for 2sec.

Initialization completed

Measurement display

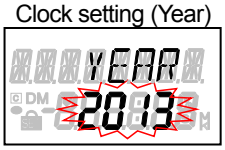
Clock setting and logging data clear

When connecting logging unit, you can set the clock of it.

On the date indication in operating mode, press both [+ / PHASE] and [- / RESET] at the same time for more than two seconds to transition to clock setting and enable the following operations.

*Caution: The date is not indicated in operating mode when the logging unit is not connected.

Clock setting (Year)

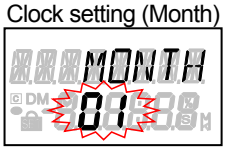


Set “Year”.

Setting range: 2000 to 2099

[SET] [DISP]

Clock setting (Month)

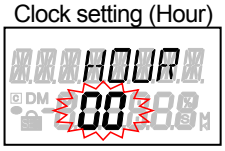


Set “Month”.

Setting range: 01 (January) to 12 (December)

[SET] [DISP]

Clock setting (Hour)

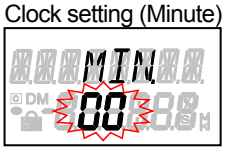


Set “Hour”.

Setting range: 00 to 23

[SET] [DISP]

Clock setting (Minute)



Set “Minute”.

Setting range: 00 to 59

[SET] [DISP]

Logging data clear confirmation

Confirm logging data clear.

“no” ⟷ “yES”
(Do not clear data) (Clear data)

- If you do not clear logging data, choose “no” and press [SET] to enter date indication (operating mode).
- If you clear logging data, choose “yES” and press [SET] to transition to below setting.

Caution: If you choose “no” (i.e. do not clear data), the clock setting is not changed.

[SET] [DISP]

Final confirmation

Confirm logging data clear finally.

“no” ⟷ “yES”
(Do not clear data) (Clear data)

- If you do not clear logging data, choose “no” and press [SET] to enter date indication (operating mode).
- If you clear logging data, choose “yES” and press [SET] to transition to below setting.

Caution: If you choose “no” (i.e. do not clear data), the clock setting is not changed.
If you choose “yES” (i.e. clear data) here, logging data is cleared, and at the same time, clock setting is changed.

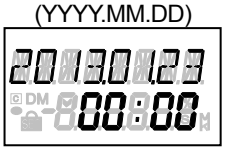
Change of date format

In date format setting, you can choose from “YYYY.MM.DD”, “MM.DD.YYYY” or “DD.MM.YYYY” format.

On the date indication in operating mode, press [+ / PHASE] for more than two seconds to transition to date format setting and enable the following operations.

*Caution: The date is not indicated in operating mode when the logging unit is not connected.

Date indication
(YYYY.MM.DD)

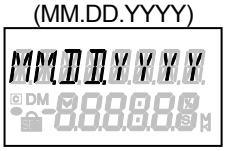


Set the date format.

YYYY.MM.DD ↔ DD.MM.YYYY ↔ MM.DD.YYYY

Press “+ / PHASE” for more than 2sec

Date format setting
(MM.DD.YYYY)



Set the date format to “MM.DD.YYYY” format.

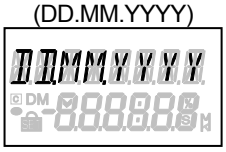
If you want to change to the other format, go back to date indication and then change format.

The display transitions to “MM.DD.YYYY” format indication (as shown in the left figure). One second later, it transitions to date indication (as shown in the right figure) automatically.

Date indication
(MM.DD.YYYY)

Press “+ / PHASE” for more than 2sec

Date format setting
(DD.MM.YYYY)



Set the date format to “DD.MM.YYYY” format.

If you want to change to the other format, go back to date indication and then change format.

The display transitions to “DD.MM.YYYY” format indication (as shown in the left figure). One second later, it transitions to date indication (as shown in the right figure) automatically.

Date indication
(DD.MM.YYYY)

Press “+ / PHASE” for more than 2sec

Date format setting
(YYYY.MM.DD)

Set the date format to “YYYY.MM.DD” format.

If you want to change to the other format, go back to date indication and then change format.

The display transitions to “YYYY.MM.DD” format indication (as shown in the left figure). One second later, it transitions to date indication (as shown in the right figure) automatically.

Date indication
(YYYY.MM.DD)

How to use test mode

Test mode has the functions which you can utilize in such as the launch of equipment.
The functions in test mode are as follows:

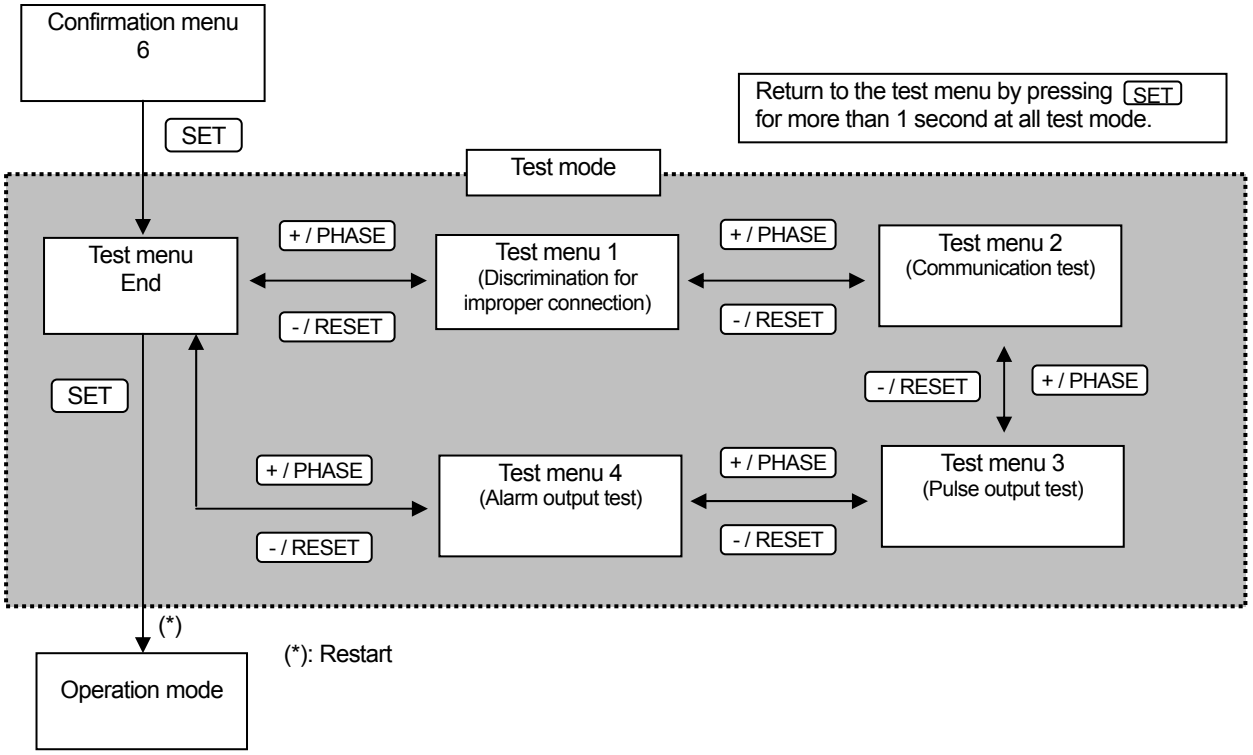
Test menu	Details
1. Discrimination support function for improper connection	Indicate phase angle of current and voltage, electric power, voltage and current of each phase. You can discriminate easily whether the input connection for measurement (voltage and current) is proper or not by checking each indicated values.
2. Communication test	For the device with communication function, it can send back the fixed numerical data without the input of measurement (voltage and current). Use for such as the opposing test to host system.
3. Pulse output test	For EMU4-HD1-MB, you can check the pulse output without the input of measurement (voltage and current). Use for such as the check of the connection to the receiving device.
4. Alarm output test	For EMU4-HD1-MB, you can check the alarm output without the input of measurement (voltage and current). Use for such as the check of the connection to the receiving device.

・ How to test

(1) Press [SET] for two seconds to enter confirmation mode.
(2) Press [+ / PHASE] or [- / RESET] to choose confirmation menu 6.
(As shown in the right figure)
(3) Press [SET] to enter test mode
(4) Test for the each menu.

(Confirmation menu 6)

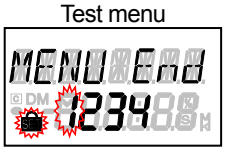
・ Diagram for test mode



Test menu 1: Discrimination support function for improper connection

In configuration mode, choose menu “6” to enter test mode. (You cannot enter from setting mode.)
In test mode, the following operations can be possible.

Test menu

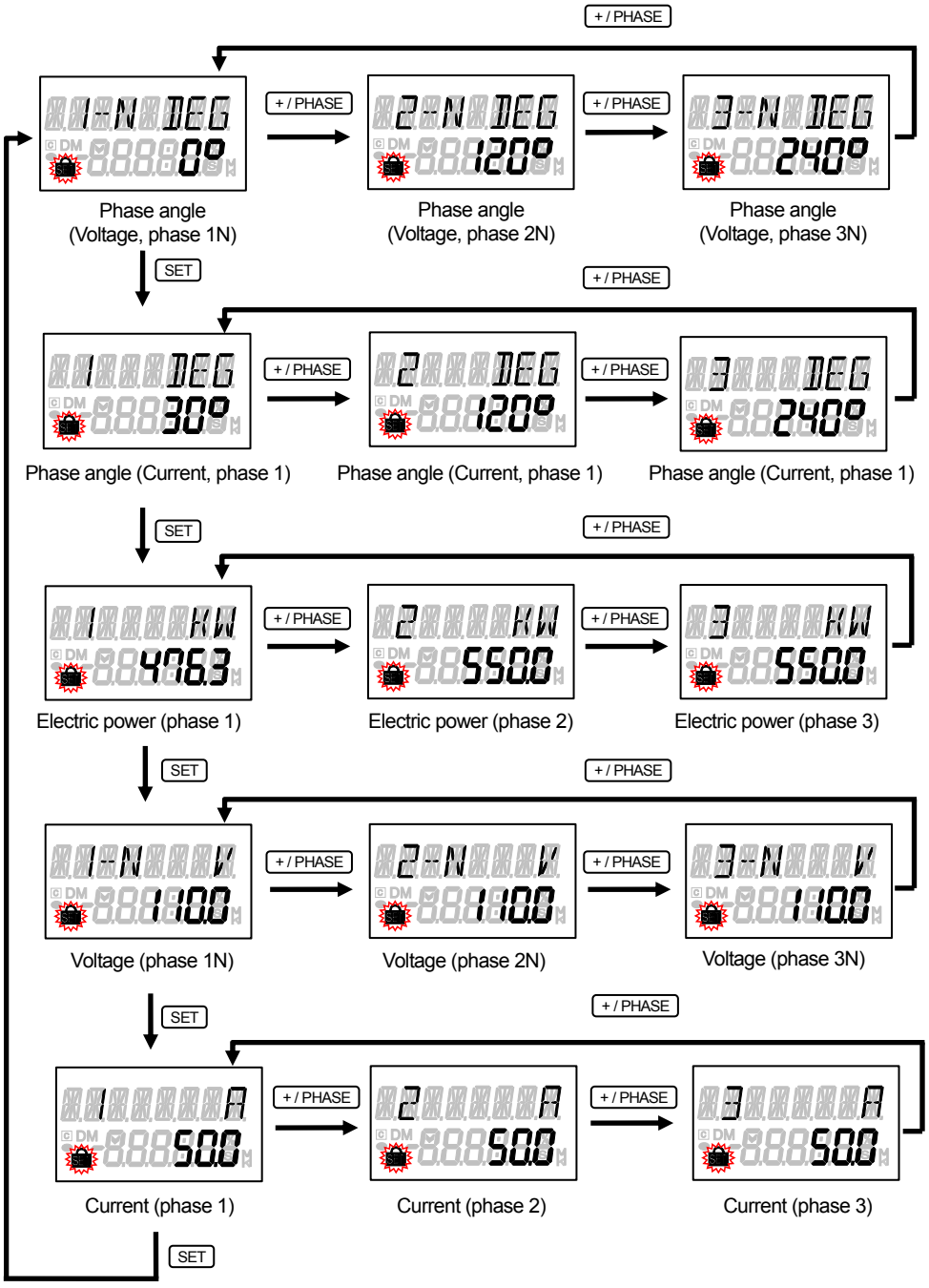


Choose the test menu 1.
(As shown in the left figure)

SET

(1) Discrimination support function for improper connection

Indicate the phase angle, electric power, voltage and current.
<Example for three-phase 4-wire>

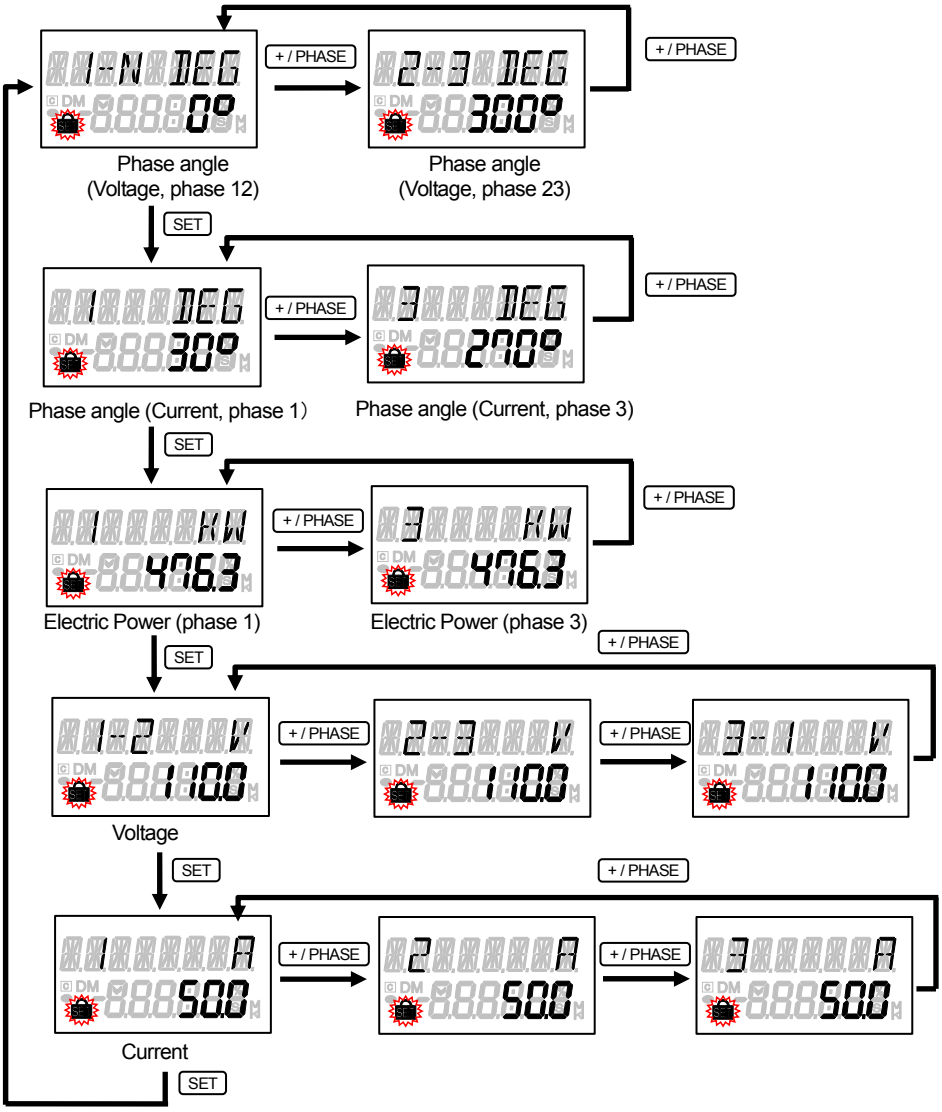


*Press SET to transition to next element from each display.

Test menu 1: Discrimination support function for improper connection

(1) Discrimination support function for improper connection

Indicate the phase angle, electric power, voltage and current.
<Example for three-phase 3-wire>

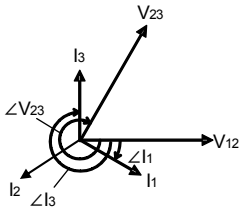


*Press SET to transition to next element from each display.

Press "SET" for more than 1sec

· About phase angle

The phase angle is indicated in a clockwise direction from V_{12}, as baseline (0 degree).



$\angle V_{23}$: Phase angle between V_{23} and V_{12}
$\angle I_1$: Phase angle between I_1 and V_{12}
$\angle I_3$: Phase angle between I_3 and V_{12}

· Display example of discrimination support function for improper connection
For display examples for each connection pattern, ☛pp. 32 - 41

Test menu

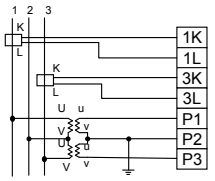
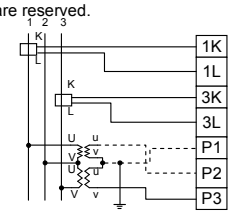
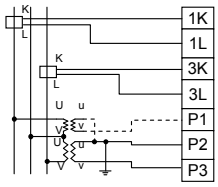
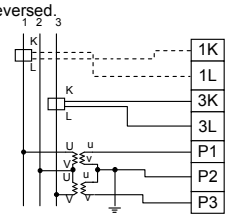
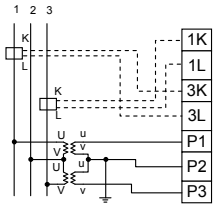
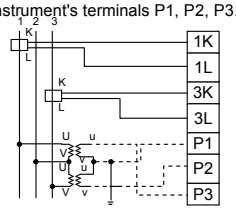
<If you continue other test menu>
→ Choose other test menu number and press SET.

<If you finish the test mode>
→ Choose "End" and press SET to return to operating mode.

Test menu 1: Discrimination support function for improper connection

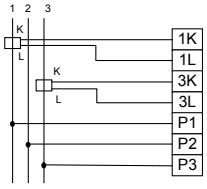
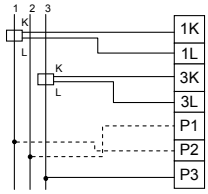
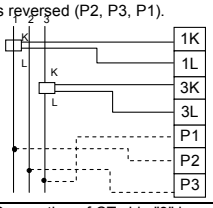
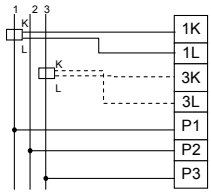
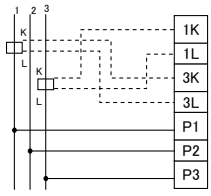
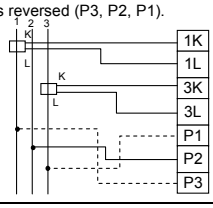
■Display example of discrimination support function for improper connection

Display example (Connection example for three-phase 3-wire) ---------- Indicates improper connection

No.	Power factor (Input)	At the average current ($V_{12}=V_{23}$、$I_1=I_3$)												Wiring
		Phase angle display				Electric power display		Voltage display			Current display			
		∠V_{12}	∠V_{23}	∠I_1	∠I_3	W_1	W_3	V_{12}	V_{23}	V_{31}	I_1	I_2	I_3	
Normal status	Forward 0.707	0	300	345	225	$W_1>W_3$		$V_{12}=V_{23}=V_{31}$			$I_1=I_2=I_3$			
	Forward 0.866			0	240									
	1			30	270	$W_1=W_3$								
	Delayed 0.866			60	300	$W_1<W_3$								
	Delayed 0.707			75	315									
1	Forward 0.707	0	60	165	45	W1=Negative value W3=Positive value		$V_{12}=V_{23}=V_{31}$			$I_1=I_2=I_3$			Connection between P1 and P2 are reserved. 
	Forward 0.866			180	60									
	1			210	90									
	Delayed 0.866			240	120									
	Delayed 0.707			255	135									
2	Forward 0.707	0	120	165	45	W1=Negative value W3=Positive value		$V_{12}=V_{23}<V_{31}$			$I_1=I_2=I_3$			Connection of VT side "1"is reversed. 
	Forward 0.866			180	60									
	1			210	90									
	Delayed 0.866			240	120									
	Delayed 0.707			255	135									
3	Forward 0.707	0	300	165	225	W1=Negative value W3=Positive value		$V_{12}=V_{23}=V_{31}$			$I_1=I_3<I_2$			Connection of CT on side "1" is reversed. 
	Forward 0.866			180	240									
	1			210	270									
	Delayed 0.866			240	300									
	Delayed 0.707			255	315									
4	Forward 0.707	0	300	225	345	W1=Negative value		$V_{12}=V_{23}=V_{31}$			$I_1=I_2=I_3$			CT side "1" and "3" are swapped. 
	Forward 0.866			240	0	W3=Positive value								
	1			270	30	$W_1=W_3=0$								
	Delayed 0.866			300	60	W1=Positive value								
	Delayed 0.707			315	75	W3=Negative value								
5	Forward 0.707	0	300	225	105	W1=Negative value		$V_{12}=V_{23}=V_{31}$			$I_1=I_2=I_3$			Connection of VT's terminals in order of P2, P3, P1 to measuring instrument's terminals P1, P2, P3. 
	Forward 0.866			240	120	W3=Negative value								
	1			270	150	W1=0 W3=Negative								
	Delayed 0.866			300	180	W1=Positive value								
	Delayed 0.707			315	195	W3=Negative value								

Display example (Connection example for single-phase 3-wire)

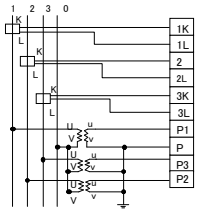
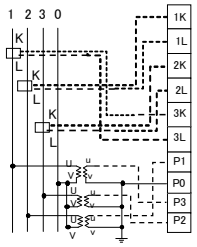
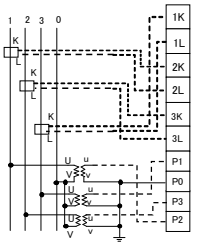
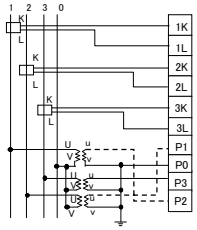
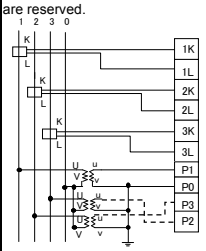
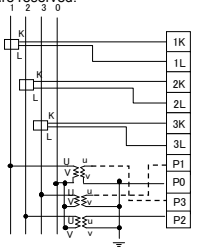
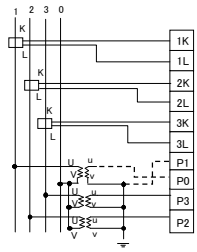
-------- Indicates improper connection

No.	Power factor (Input)	At the average current ($V_{12}=V_{23}$、$I_1=I_3$)												Connection					
		Phase angle display				Electric power display		Voltage display			Current display			Voltage			Current		Connecting diagram
		$\angle V_{12}$	$\angle V_{23}$	$\angle I_1$	$\angle I_3$	W_1	W_3	V_{12}	V_{23}	V_{31}	I_1	I_2	I_3	1	2	3	CT(side "1")	CT(side "3")	
Normal status	Forward 0.707	0	180	315	135	$W_1=W_3$		$V_{12}=V_{23}<V_{31}$			$I_1=I_3$ $I_2=0$			P1	P2	P3	1K 1L Forward	3K 3L Forward	
	Forward 0.866			330	150														
	1			0	180														
	Delayed 0.866			30	210														
	Delayed 0.707			45	225														
1	Forward 0.707	0	0	135	315	W1= Negative value W3= Positive value		$V_{12}=V_{23}<V_{31}$			$I_1=I_3$ $I_2=0$			P2	P1	P3	1K 1L Forward	3K 3L Forward	Connection between P1 and P2 are reserved. 
	Forward 0.866			150	330														
	1			180	0														
	Delayed 0.866			210	30														
	Delayed 0.707			225	45														
2	Forward 0.707	0	0	135	315	W1= Negative value W3= Positive value		$V_{12}>V_{23}=V_{31}$			$I_1=I_3$ $I_2=0$			P2	P3	P1	1K 1L Forward	3K 3L Forward	Connection of P1, P2, P3 terminals of measuring instrument is reversed (P2, P3, P1). 
	Forward 0.866			150	330														
	1			180	0														
	Delayed 0.866			210	30														
	Delayed 0.707			225	45														
3	Forward 0.707	0	180	315	315	W1= Positive value W3= Negative value		$V_{12}=V_{23}<V_{31}$			$I_1=I_3<I_2$			P1	P2	P3	3K 3L Forward	3K 3L Reverse	Connection of CT side "3" is reversed. 
	Forward 0.866			330	330														
	1			0	0														
	Delayed 0.866			30	30														
	Delayed 0.707			45	45														
4	Forward 0.707	0	180	135	315	W1= Negative value W3= Negative value		$V_{12}=V_{23}<V_{31}$			$I_1=I_3$ $I_2=0$			P1	P2	P3	3K 3L Forward	1K 1L Forward	CT side "1" and "3" are swapped. 
	Forward 0.866			150	330														
	1			180	0														
	Delayed 0.866			210	30														
	Delayed 0.707			225	45														
5	Forward 0.707	0	180	135	315	W1= Negative value W3= Negative value		$V_{12}=V_{23}<V_{31}$			$I_1=I_3$ $I_2=0$			P3	P2	P1	1K 1L Forward	3K 3L Forward	Connection of P1, P2, P3 terminals of measuring instrument is reversed (P3, P2, P1). 
	Forward 0.866			150	330														
	1			180	0														
	Delayed 0.866			210	30														
	Delayed 0.707			225	45														

■Display example of discrimination support function for improper connection.

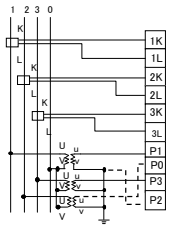
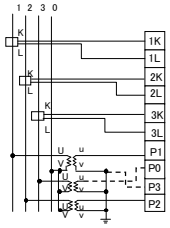
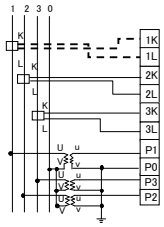
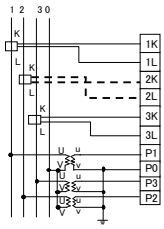
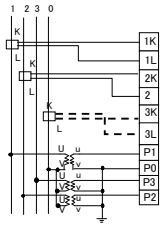
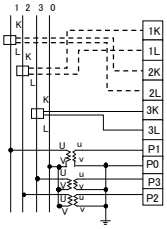
Display example (connection example for three-phase 4-wire)

------- Indicates improper connection

No.	Power factor (input)	Phase angle display						At the average current (V1N=V2N=V3N, I1=I2=I3)									Wiring
								Electric power display			Voltage display			Current display			
		∠V1N	∠V2N	∠V3N	∠I1	∠I2	∠I3	W1	W2	W3	V1N	V2N	V3N	I1	I2	I3	
Normal status	Forward 0.707	0	120	240	315	75	195	W1=W2=W3			V1N=V2N=V3N			I1=I2=I3			
	Forward 0.866				330	90	210										
	1				0	120	240										
	Delayed 0.866				30	150	270										
	Delayed 0.707				45	165	285										
1	Forward 0.707	0	120	240	315	75	195	W1=W2=W3			V1N=V2N=V3N			I1=I2=I3			Negative phase sequence1  Negative phase sequence 2 
	Forward 0.866				330	90	210										
	1				0	120	240										
	Delayed 0.866				30	150	270										
	Delayed 0.707				45	165	285										
2	Forward 0.707	0	240	120	190	315	75	W1=Negative value W2=Positive value W3=Positive value			V1N=V2N=V3N			I1=I2=I3			Connection between P1 and P2 are reserved. 
	Forward 0.866				210	330	90	W1=Negative value W2=0 W3=Positive value									
	1				240	0	120	W1=Negative value W2=Negative value W3=Positive value									
	Delayed 0.866				270	30	150	W1=0 W2=Negative value W3=Positive value									
	Delayed 0.707				285	45	165	W1=Positive value W2=Negative value W3=Positive value									
3	Forward 0.707	0	240	120	315	75	195	W1=Positive value W2=Negative value W3=Positive value			V1N=V2N=V3N			I1=I2=I3			Connection between P2 and P3 are reserved. 
	Forward 0.866				330	90	210	W1=Positive value W2=Negative value W3=0									
	1				0	120	240	W1=Positive value W2=Negative value W3=Negative value									
	Delayed 0.866				30	150	270	W1=Positive value W2=0 W3=Negative value									
	Delayed 0.707				45	165	285	W1=Positive value W2=Positive value W3=Negative value									
4	Forward 0.707	0	240	120	75	195	315	W1=Positive value W2=Positive value W3=Negative value			V1N=V2N=V3N			I1=I2=I3			Connection between P1 and P3 are reserved. 
	Forward 0.866				90	210	330	W1=0 W2=Positive value W3=Negative value									
	1				120	240	0	W1=Negative value W2=Positive value W3=Negative value									
	Delayed 0.866				150	270	30	W1=Negative value W2=Positive value W3=0									
	Delayed 0.707				165	285	45	W1=Negative value W2=Positive value W3=Positive value									
5	Forward 0.707	0	330	30	135	255	15				V1N<V2N=V3N			I1=I2=I3			Connection between P1 and P0 are reserved. 
	Forward 0.866				150	270	30										
	1				180	300	60	W1=Negative value W2=Positive value W3=Positive value									
	Delayed 0.866				210	330	90										
	Delayed 0.707				225	345	105										

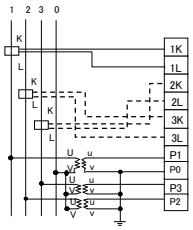
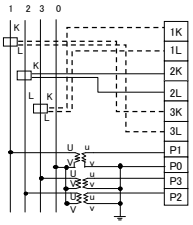
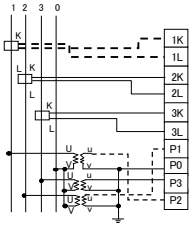
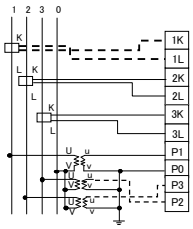
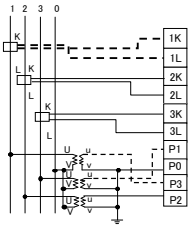
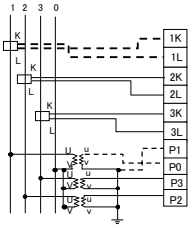
Display example (connection example for three-phase 4-wire)

------- Indicates improper connection

No.	Power factor (input)	Phase angle display						At the average current (V1N=V2N=V3N, I1=I2=I3)								Wiring
								Electric power display			Voltage display			Current display		
		∠V1N	∠V2N	∠V3N	∠I1	∠I2	∠I3	W1	W2	W3	V1N	V2N	V3N	I1	I2	I3	
6	Forward 0.707	0	330	300	345	105	225	W1=Positive value W2=Negative value W3=Positive value			V1N=V3N>V2N			I1=I2=I3			Connection between P2 and P0 are reserved. 
	Forward 0.866				0	120	240										
	1				30	150	270										
	Delayed 0.866				60	180	300										
	Delayed 0.707				75	195	315										
7	Forward 0.707	0	60	30	285	45	165	W1=Positive value W2=Positive value W3=Negative value			V1N=V2N>V3N			I1=I2=I3			Connection between P3 and P0 are reserved. 
	Forward 0.866				300	60	180										
	1				330	90	210										
	Delayed 0.866				0	120	240										
	Delayed 0.707				15	135	255										
8	Forward 0.707	0	120	240	135	75	195	W1=Negative value W2=Positive value W3=Positive value			V1N=V2N=V3N			I1=I2=I3			Connection of CT on side "1" is reserved. 
	Forward 0.866				150	90	210										
	1				180	120	240										
	Delayed 0.866				210	150	270										
	Delayed 0.707				225	165	285										
9	Forward 0.707	0	120	240	315	255	195	W1=Positive value W2=Negative value W3=Positive value			V1N=V2N=V3N			I1=I2=I3			Connection of CT on side "2" is reserved. 
	Forward 0.866				330	270	210										
	1				0	300	240										
	Delayed 0.866				30	330	270										
	Delayed 0.707				45	345	285										
10	Forward 0.707	0	120	240	315	75	15	W1=Positive value W2=Positive value W3=Negative value			V1N=V2N=V3N			I1=I2=I3			Connection of CT on side "3" is reserved. 
	Forward 0.866				330	90	30										
	1				0	120	60										
	Delayed 0.866				30	150	90										
	Delayed 0.707				45	165	105										
11	Forward 0.707	0	120	240	75	315	195	W1=Positive value W2=Negative value W3=Positive value			V1N=V2N=V3N			I1=I2=I3			CT side "1" and "2" are swapped. 
	Forward 0.866				90	330	210	W1=0 W2=Negative value W3=Positive value									
	1				120	0	240	W1=Negative value W2=Negative value W3=Positive value									
	Delayed 0.866				150	30	270	W1=Negative value W2=0 W3=Positive value									
	Delayed 0.707				165	45	285	W1=Negative value W2=Positive value W3=Positive value									

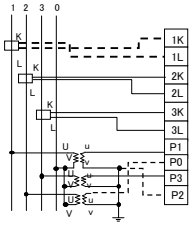
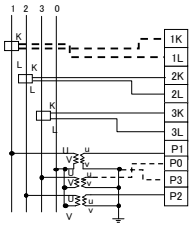
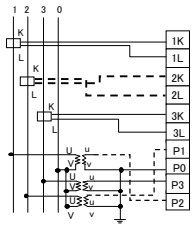
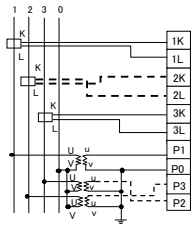
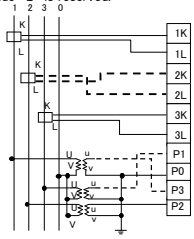
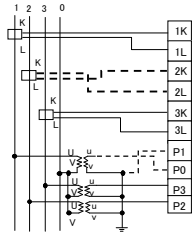
Display example (connection example for three-phase 4-wire)

------- Indicates improper connection

No.	Power factor (input)	Phase angle display						At the average current (V1N=V2N=V3N, I1=I2=I3)									Wiring
								Electric power display			Voltage display			Current display			
		∠V1N	∠V2N	∠V3N	∠I1	∠I2	∠I3	W1	W2	W3	V1N	V2N	V3N	I1	I2	I3	
12	Forward 0.707	0	120	240	315	195	75	W1=Positive value W2=Positive value W3=Negative value			V1N=V2N=V3N			I1=I2=I3			CT side "2" and "3" are swapped. 
	Forward 0.866				330	210	90	W1=Positive value W2=0 W3=Negative value									
	1				0	240	120	W1=Positive value W2=Negative value W3=Negative value									
	Delayed 0.866				30	270	150	W1=Positive value W2=Negative value W3=0									
	Delayed 0.707				45	285	165	W1=Positive value W2=Negative value W3=Positive value									
13	Forward 0.707	0	120	240	195	75	315	W1=Negative value W2=Positive value W3=Positive value			V1N=V2N=V3N			I1=I2=I3			CT side "1" and "3" are swapped. 
	Forward 0.866				210	90	330	W1=Negative value W2=Positive value W3=0									
	1				240	120	0	W1=Negative value W2=Positive value W3=Negative value									
	Delayed 0.866				270	150	30	W1=0 W2=Positive value W3=Negative value									
	Delayed 0.707				285	165	45	W1=Positive value W2=Positive value W3=Negative value									
14	Forward 0.707	0	240	120	15	315	75	W1=Positive value W2=Positive value W3=Positive value			V1N=V2N=V3N			I1=I2=I3			Connection between P1 and P2 are reserved. And connection of CT on side "1" is reserved. 
	Forward 0.866				30	330	90	W1=Positive value W2=0 W3=Positive value									
	1				60	0	120	W1=Positive value W2=Negative value W3=Positive value									
	Delayed 0.866				90	30	150	W1=0 W2=Negative value W3=Positive value									
	Delayed 0.707				105	45	165	W1=Negative value W2=Negative value W3=Positive value									
15	Forward 0.707	0	240	120	135	75	195	W1=Negative value W2=Negative value W3=Positive value			V1N=V2N=V3N			I1=I2=I3			Connection between P2 and P3 are reserved. And connection of CT on side "1" is reserved. 
	Forward 0.866				150	90	210	W1=Negative value W2=Negative value W3=0									
	1				180	120	240	W1=Negative value W2=Negative value W3=Negative value									
	Delayed 0.866				210	150	270	W1=Negative value W2=0 W3=Negative value									
	Delayed 0.707				225	165	285	W1=Negative value W2=Positive value W3=Negative value									
16	Forward 0.707	0	240	120	255	195	315	W1=Negative value W2=Positive value W3=Negative value			V1N=V2N=V3N			I1=I2=I3			Connection between P1 and P3 are reserved. And connection of CT on side "1" is reserved. 
	Forward 0.866				270	210	330	W1=0 W2=Positive value W3=Negative value									
	1				300	240	0	W1=Positive value W2=Positive value W3=Negative value									
	Delayed 0.866				330	270	30	W1=Positive value W2=Positive value W3=0									
	Delayed 0.707				345	285	45	W1=Positive value W2=Positive value W3=Positive value									
17	Forward 0.707	0	330	30	315	255	15	W1=Positive value W2=Positive value W3=Positive value			V1N<V2N=V3N			I1=I2=I3			Connection between P1 and P0 are reserved. And connection of CT on side "1" is reserved. 
	Forward 0.866				330	270	30										
	1				0	300	60										
	Delayed 0.866				30	330	90										
	Delayed 0.707				45	345	105										

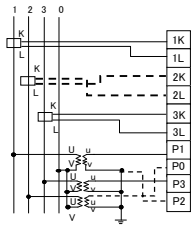
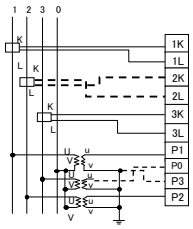
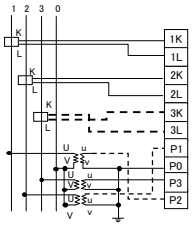
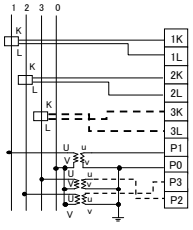
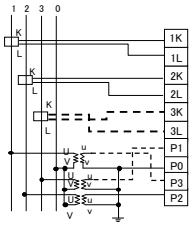
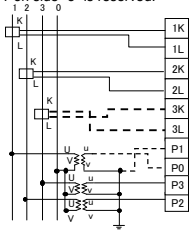
Display example (connection example for three-phase 4-wire)

------- Indicates improper connection

No.	Power factor (input)	Phase angle display						At the average current (V1N=V2N=V3N, I1=I2=I3) Electric power display			Voltage display			Current display			Wiring
		∠V1N	∠V2N	∠V3N	∠I1	∠I2	∠I3	W1	W2	W3	V1N	V2N	V3N	I1	I2	I3	
18	Forward 0.707	0	330	300	165	105	225	W1=Negative value W2=Negative value W3=Positive value			V1N=V3N>V2N			I1=I2=I3			Connection between P2 and P0 are reserved. And connection of CT on side "1" is reserved. 
	Forward 0.866				180	120	240										
	1				210	150	270										
	Delayed 0.866				240	180	300										
	Delayed 0.707				255	195	315										
19	Forward 0.707	0	60	30	105	45	165	W1=Negative value W2=Positive value W3=Negative value			V1N=V2N>V3N			I1=I2=I3			Connection between P3 and P0 are reserved. And connection of CT on side "1" is reserved. 
	Forward 0.866				120	60	180										
	1				150	90	210										
	Delayed 0.866				180	120	240										
	Delayed 0.707				195	135	255										
20	Forward 0.707	0	240	120	195	135	75	W1=Negative value W2=Negative value W3=Positive value			V1N=V2N=V3N			I1=I2=I3			Connection between P1 and P2 are reserved. And connection of CT on side "2" is reserved. 
	Forward 0.866				210	150	90	W1=Negative value W2=0 W3=Positive value									
	1				240	180	120	W1=Negative value W2=Positive value W3=Positive value									
	Delayed 0.866				270	210	150	W1=0 W2=Positive value W3=Positive value									
	Delayed 0.707				285	225	165	W1=Positive value W2=Positive value W3=Positive value									
21	Forward 0.707	0	240	120	315	255	195	W1=Positive value W2=Positive value W3=Positive value			V1N=V2N=V3N			I1=I2=I3			Connection between P2 and P3 are reserved. And connection of CT on side "2" is reserved. 
	Forward 0.866				330	270	210	W1=Positive value W2=Positive value W3=0									
	1				0	300	240	W1=Positive value W2=Positive value W3=Negative value									
	Delayed 0.866				30	330	270	W1=Positive value W2=0 W3=Negative value									
	Delayed 0.707				45	345	285	W1=Positive value W2=Negative value W3=Negative value									
22	Forward 0.707	0	240	120	75	15	315	W1=Positive value W2=Negative value W3=Negative value			V1N=V2N=V3N			I1=I2=I3			Connection between P1 and P3 are reserved. And connection of CT on side "2" is reserved. 
	Forward 0.866				90	30	330	W1=0 W2=Negative value W3=Negative value									
	1				120	60	0	W1=Negative value W2=Negative value W3=Negative value									
	Delayed 0.866				150	90	30	W1=Negative value W2=Negative value W3=0									
	Delayed 0.707				165	105	45	W1=Negative value W2=Negative value W3=Positive value									
23	Forward 0.707	0	330	30	135	75	15	W1=Negative value W2=Negative value W3=Positive value			V1N<V2N=V3N			I1=I2=I3			Connection between P1 and P0 are reserved. And connection of CT on side "2" is reserved. 
	Forward 0.866				150	90	30										
	1				180	120	60										
	Delayed 0.866				210	150	90										
	Delayed 0.707				225	165	105										

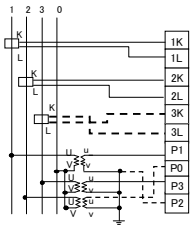
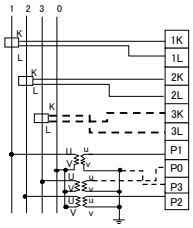
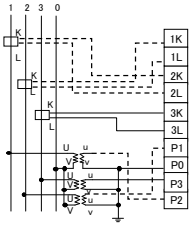
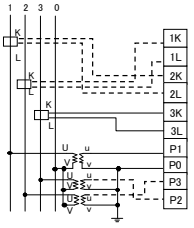
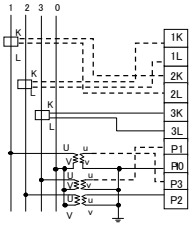
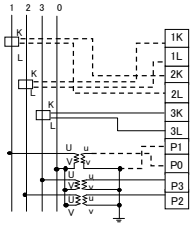
Display example (connection example for three-phase 4-wire)

------- Indicates improper connection

No.	Power factor (input)	Phase angle display						At the average current (V1N=V2N=V3N, I1=I2=I3)								Wiring
								Electric power display			Voltage display			Current display		
		∠V1N	∠V2N	∠V3N	∠I1	∠I2	∠I3	W1	W2	W3	V1N	V2N	V3N	I1	I2	I3	
24	Forward 0.707	0	330	300	345	285	225	W1=Positive value W2=Positive value W3=Positive value			V1N=V3N>V2N			I1=I2=I3			Connection between P2 and P0 are reserved. And connection of CT on side "2" is reserved. 
	Forward 0.866				0	300	240										
	1				30	330	270										
	Delayed 0.866				60	0	300										
	Delayed 0.707				75	15	315										
25	Forward 0.707	0	60	30	285	225	165	W1=Positive value W2=Negative value W3=Negative value			V1N=V2N>V3N			I1=I2=I3			Connection between P3 and P0 are reserved. And connection of CT on side "2" is reserved. 
	Forward 0.866				300	240	180										
	1				330	270	210										
	Delayed 0.866				0	300	240										
	Delayed 0.707				15	315	255										
26	Forward 0.707	0	240	120	195	315	255	W1=Negative value W2=Positive value W3=Negative value			V1N=V2N=V3N			I1=I2=I3			Connection between P1 and P2 are reserved. And connection of CT on side "3" is reserved. 
	Forward 0.866				210	330	270	W1=Negative value W2=0 W3=Negative value									
	1				240	0	300	W1=Negative value W2=Negative value W3=Negative value									
	Delayed 0.866				270	30	330	W1=0 W2=Negative value W3=Negative value									
	Delayed 0.707				285	45	345	W1=Positive value W2=Negative value W3=Negative value									
27	Forward 0.707	0	240	120	315	75	15	W1=Positive value W2=Negative value W3=Negative value			V1N=V2N=V3N			I1=I2=I3			Connection between P2 and P3 are reserved. And connection of CT on side "3" is reserved. 
	Forward 0.866				330	90	30	W1=Positive value W2=Negative value W3=0									
	1				0	120	60	W1=Positive value W2=Negative value W3=Positive value									
	Delayed 0.866				30	150	90	W1=Positive value W2=0 W3=Positive value									
	Delayed 0.707				45	165	105	W1=Positive value W2=Positive value W3=Positive value									
28	Forward 0.707	0	240	120	75	195	135	W1=Positive value W2=Positive value W3=Positive value			V1N=V2N=V3N			I1=I2=I3			Connection between P1 and P3 are reserved. And connection of CT on side "3" is reserved. 
	Forward 0.866				90	210	150	W1=0 W2=Positive value W3=Positive value									
	1				120	240	180	W1=Negative value W2=Positive value W3=Positive value									
	Delayed 0.866				150	270	210	W1=Negative value W2=Positive value W3=0									
	Delayed 0.707				165	285	225	W1=Negative value W2=Positive value W3=Negative value									
29	Forward 0.707	0	330	30	135	255	195	W1=Negative value W2=Positive value W3=Negative value			V1N<V2N=V3N			I1=I2=I3			Connection between P1 and P0 are reserved. And connection of CT on side "3" is reserved. 
	Forward 0.866				150	270	210										
	1				180	300	240										
	Delayed 0.866				210	330	270										
	Delayed 0.707				225	345	285										

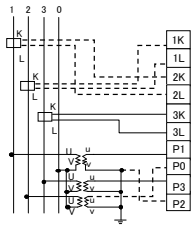
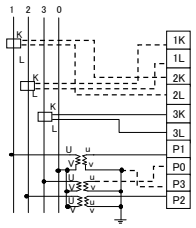
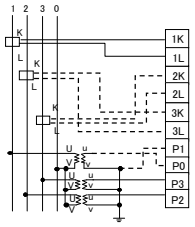
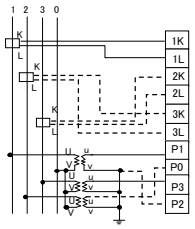
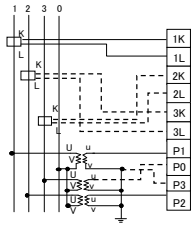
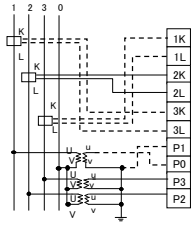
Display example (connection example for three-phase 4-wire)

------- Indicates improper connection

No.	Power factor (input)	Phase angle display						At the average current (V1N=V2N=V3N, I1=I2=I3)							Wiring
								Electric power display			Voltage display			Current display	
		∠V1N	∠V2N	∠V3N	∠I1	∠I2	∠I3	W1	W2	W3	V1N	V2N	V3N	I1	I2	I3	
30	Forward 0.707	0	330	300	345	105	45	W1=Positive value W2=Negative value W3=Negative value			V1N=V3N>V2N			I1=I2=I3			Connection between P2 and P0 are reserved. And connection of CT on side "3" is reserved. 
	Forward 0.866				0	120	60										
	1				30	150	90										
	Delayed 0.866				60	180	120										
	Delayed 0.707				75	195	135										
31	Forward 0.707	0	60	30	285	45	345	W1=Positive value W2=Positive value W3=Positive value			V1N=V2N>V3N			I1=I2=I3			Connection between P3 and P0 are reserved. And connection of CT on side "3" is reserved. 
	Forward 0.866				300	60	0										
	1				330	90	30										
	Delayed 0.866				0	120	60										
	Delayed 0.707				15	135	75										
32	Forward 0.707	0	240	120	315	195	75	W1=W2=W3			V1N=V2N=V3N			I1=I2=I3			Connection between P1 and P2 are reserved. And CT side "1" and "2" are swapped. 
	Forward 0.866				330	210	90										
	1				0	240	120										
	Delayed 0.866				30	270	150										
	Delayed 0.707				45	285	165										
33	Forward 0.707	0	240	120	75	315	195	W1=W2=W3			V1N=V2N=V3N			I1=I2=I3			Connection between P2 and P3 are reserved. And CT side "1" and "2" are swapped. 
	Forward 0.866				90	330	210										
	1				120	0	240										
	Delayed 0.866				150	30	270										
	Delayed 0.707				165	45	285										
34	Forward 0.707	0	240	120	195	75	315	W1=W2=W3			V1N=V2N=V3N			I1=I2=I3			Connection between P1 and P3 are reserved. And CT side "1" and "2" are swapped. 
	Forward 0.866				210	90	330										
	1				240	120	0										
	Delayed 0.866				270	150	30										
	Delayed 0.707				285	165	45										
35	Forward 0.707	0	330	30	255	135	15	W1=Negative value W2=Negative value W3=Positive value			V1N<V2N=V3N			I1=I2=I3			Connection between P1 and P0 are reserved. And CT side "1" and "2" are swapped. 
	Forward 0.866				270	150	30	W1=0 W2=Negative value W3=Positive value									
	1				300	180	60										
	Delayed 0.866				330	210	90	W1=Positive value W2=Negative value W3=Positive value									
	Delayed 0.707				345	225	105										

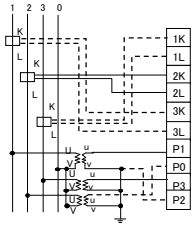
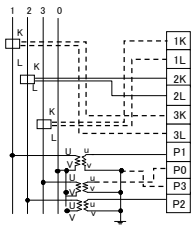
Display example (connection example for three-phase 4-wire)

------- Indicates improper connection

No.	Power factor (input)	Phase angle display						At the average current (V1N=V2N=V3N, I1=I2=I3)								Wiring
								Electric power display			Voltage display			Current display		
		∠V1N	∠V2N	∠V3N	∠I1	∠I2	∠I3	W1	W2	W3	V1N	V2N	V3N	I1	I2	I3	
36	Forward 0.707	0	330	300	105	345	225	W1=Negative value W2=Positive value W3=Positive value			V1N=V3N>V2N			I1=I2=I3			Connection between P2 and P0 are reserved. And CT side "1" and "2" are swapped. 
	Forward 0.866				120	0	240									
	1				150	30	270									
	Delayed 0.866				180	60	300	W1=Negative value W2=0 W3=Positive value								
	Delayed 0.707				195	75	315	W1=Negative value W2=Negative value W3=Positive value								
37	Forward 0.707	0	60	30	45	285	165	W1=Positive value W2=Negative value W3=Negative value			V1N=V2N>V3N			I1=I2=I3			Connection between P3 and P0 are reserved. And CT side "1" and "2" are swapped. 
	Forward 0.866				60	300	180									
	1				90	330	210	W1=0 W2=0 W3=Negative value								
	Delayed 0.866				120	0	240	W1=Negative value W2=Positive value W3=Negative value								
	Delayed 0.707				135	15	255									
38	Forward 0.707	0	330	30	135	15	255	W1=Negative value W2=Positive value W3=Negative value			V1N<V2N=V3N			I1=I2=I3			Connection between P1 and P0 are reserved. And CT side "2" and "3" are swapped. 
	Forward 0.866				150	30	270									
	1				180	60	300	W1=Negative value W2=0 W3=0								
	Delayed 0.866				210	90	330	W1=Negative value W2=Negative value W3=Positive value								
	Delayed 0.707				225	105	345									
39	Forward 0.707	0	330	300	345	225	105	W1=Positive value W2=Negative value W3=Negative value			V1N=V3N>V2N			I1=I2=I3			Connection between P2 and P0 are reserved. And CT side "2" and "3" are swapped. 
	Forward 0.866				0	240	120	W1=Positive value W2=0 W3=Negative value								
	1				30	270	150									
	Delayed 0.866				60	300	180	W1=Positive value W2=Positive value W3=Negative value								
	Delayed 0.707				75	315	195									
40	Forward 0.707	0	60	30	285	165	45	W1=Positive value W2=Negative value W3=Positive value			V1N=V2N>V3N			I1=I2=I3			Connection between P3 and P0 are reserved. And CT side "2" and "3" are swapped. 
	Forward 0.866				300	180	60									
	1				330	210	90									
	Delayed 0.866				0	240	120	W1=Positive value W2=Negative value W3=0								
	Delayed 0.707				15	255	135	W1=Positive value W2=Negative value W3=Negative value								
41	Forward 0.707	0	330	30	15	255	135	W1=Positive value W2=Positive value W3=Negative value			V1N<V2N=V3N			I1=I2=I3			Connection between P1 and P0 are reserved. And CT side "1" and "3" are swapped. 
	Forward 0.866				30	270	150									
	1				60	300	180									
	Delayed 0.866				90	330	210	W1=0 W2=Positive value W3=Negative value								
	Delayed 0.707				105	345	225	W1=Negative value W2=Positive value W3=Negative value								

Display example (connection example for three-phase 4-wire)

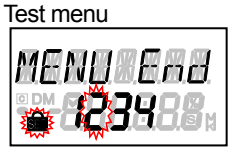
------- Indicates improper connection

No.	Power factor (input)	Phase angle display						At the average current (V1N=V2N=V3N, I1=I2=I3)									Wiring
								Electric power display			Voltage display			Current display			
		∠V1N	∠V2N	∠V3N	∠I1	∠I2	∠I3	W1	W2	W3	V1N	V2N	V3N	I1	I2	I3	
42	Forward 0.707	0	330	300	225	105	345	W1=Negative value W2=Negative value W3=Positive value			V1N=V3N>V2N			I1=I2=I3			Connection between P2 and P0 are reserved. And CT side "1" and "3" are swapped. 
	Forward 0.866				240	120	0										
	1				270	150	30	W1=0 W2=Negative value W3=0									
	Delayed 0.866				300	180	60	W1=Positive value W2=Negative value W3=Negative value									
	Delayed 0.707				315	195	75										
42	Forward 0.707	0	60	30	165	45	285	W1=Negative value W2=Positive value W3=Negative value			V1N=V2N>V3N			I1=I2=I3			Connection between P3 and P0 are reserved. And CT side "1" and "3" are swapped. 
	Forward 0.866				180	60	300	W1=Negative value W2=Positive value W3=0									
	1				210	90	330										
	Delayed 0.866				240	120	0	W1=Negative value W2=Positive value W3=Positive value									
	Delayed 0.707				255	135	15										

Test menu 2: Communication test

In test mode, the following operations can be possible.

Test menu



Choose the test menu 2.
(As shown in the left figure)

SET

(2) Communication test

Press “SET” for more than 1sec

Test menu

Test the communication.
(You can monitor non-zero values without voltage or current input.)

- Monitored value in communication
  - Monitored element and value are those indicated in display.
    Monitored value of measured element which is not indicated in display is zero, except the power factor is 100.0%.

- Display

- Indication is made according to the setting of indication pattern, etc. as with operating mode.

- Button operation

Operation	Function
Press DISP	Change element
Press + / PHASE	Change phase
Press - / RESET	Change degree(indication of harmonic only)
Press SET for more than 1sec	Return to test menu

<If you continue other test menu>
→ Choose other test menu number and press SET.

<If you finish the test mode>
→ Choose “End” and press SET to return to operating mode.

Test menu 3: Pulse output test

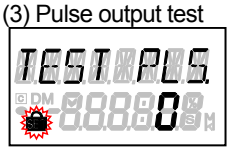
In test mode, the following operations can be possible.

Test menu

Choose the test menu 3.
(As shown in the left figure)

SET

(3) Pulse output test



Test the pulse output. (Input is unnecessary.)
Press [+ / PHASE] to output 1pulse.

[+ / PHASE]

0 → 1 → 2 → ··· → 49 → 50 [pulse]

Display indicates the present output pulse count.
If count becomes 50, it is reset to1 at next output.

Press "SET"
for more than 1sec

Test menu

<If you continue other test menu>
→ Choose other test menu number and press [SET]

<If you finish the test mode>
→ Choose "End" and press [SET] to return to operating mode.

Test menu 4: Alarm output test

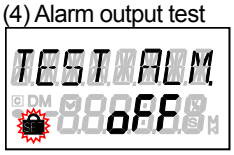
In test mode, the following operations can be possible.

Test menu

Choose the test menu 4.
(As shown in the left figure)

SET

(4) Alarm output test



Test the alarm output.
Switch output status off and on by pressing [+ / PHASE] .

[+ / PHASE]

oFF ⟷ on

Supplement:
Output should turn "oFF"
when returning to test menu.

Press "SET"
for more than 1sec

Test menu

<If you continue other test menu>
→ Choose other test menu number and press [SET]

<If you finish the test mode>
→ Choose "End" and press [SET] to return to operating mode.

Operation procedure in operating mode

This unit indicates the measured value of each item in operating mode. (For the measured items which can be indicated, ☛page 53)

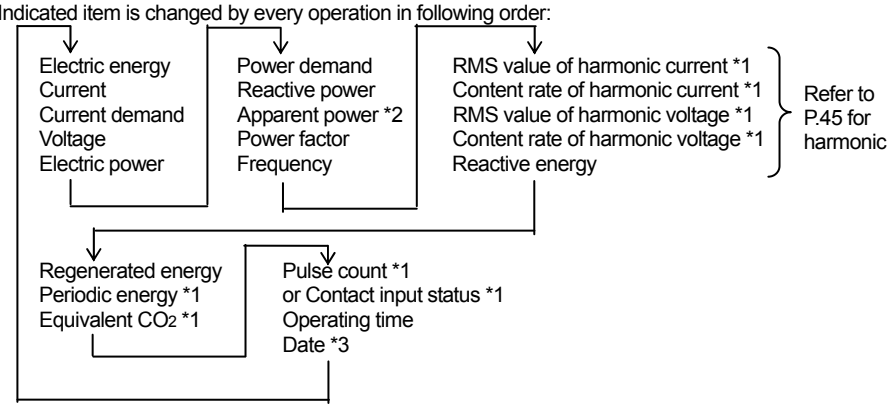
Operation procedure to change the measured item indicated is as follows:

Change the indicated item

Operation: Press [DISP]

Details:

Indicated item is changed by every operation in following order:



Supplement:
*1: Indicated only when EMU4-HD1-MB using.
*2: Indicated in three-phase 4-wire (3P4W) only.
*3: Date is only indicated when the logging unit is connected.

	External input method	Contact				Pulse			
Setting	Equivalent CO2 indication	Invalid		Valid		Invalid		Valid	
	Operating time indication	Invalid	Valid	Invalid	Valid	Invalid	Valid	Invalid	Valid
Indication	Contact input status	OK	OK	OK	OK	N/A	N/A	N/A	N/A
	Equivalent CO2	N/A	N/A	OK	OK	N/A	N/A	OK	OK
	Operating time	N/A	OK	N/A	OK	N/A	OK	N/A	OK
	Periodic energy	OK	OK	OK	OK	N/A	N/A	N/A	N/A
	Pulse count	N/A	N/A	N/A	N/A	OK	OK	OK	OK

Setting	Harmonic current indication	Invalid		Valid	
	Harmonic voltage indication	Invalid	Valid	Invalid	Valid
Indication	Harmonic current	N/A	N/A	OK	OK
	Harmonic voltage	N/A	OK	N/A	OK

Supplement: Items except for operating time can be indicated on EMU4-HD1-MB only.

Change phase

Operation: Press [+ / PHASE]

Details:

Phase is changed by every operation in following order:

Indicated item	Order of change
Present current value	1-phase → 2-phase → 3-phase → N-phase* → Average → 1-phase → ⋯
Present current demand value	1-phase → 2-phase → 3-phase → N-phase* → 1-phase → ⋯
Present voltage value	phase 12 → phase 23 → phase 31 →phase 1N* → phase 2N* →phase 3N* → Average → phase 12 →⋯
Harmonic current	phase 1→phase 2→phase 3→phase N* →phase 1→ ⋯
Harmonic voltage (except for 3P4W)	phase 12→phase 23→phase 12→ ⋯
Harmonic voltage (3P4W)	phase 1N* →phase 2N*→phase 3N* →phase 1N* → ⋯

*: Indicated in three-phase 4-wire (3P4W) only.
Supplement: Phase is not changed in the items except above regardless of phase wire system.
For average current and average voltage, ☛page 54.

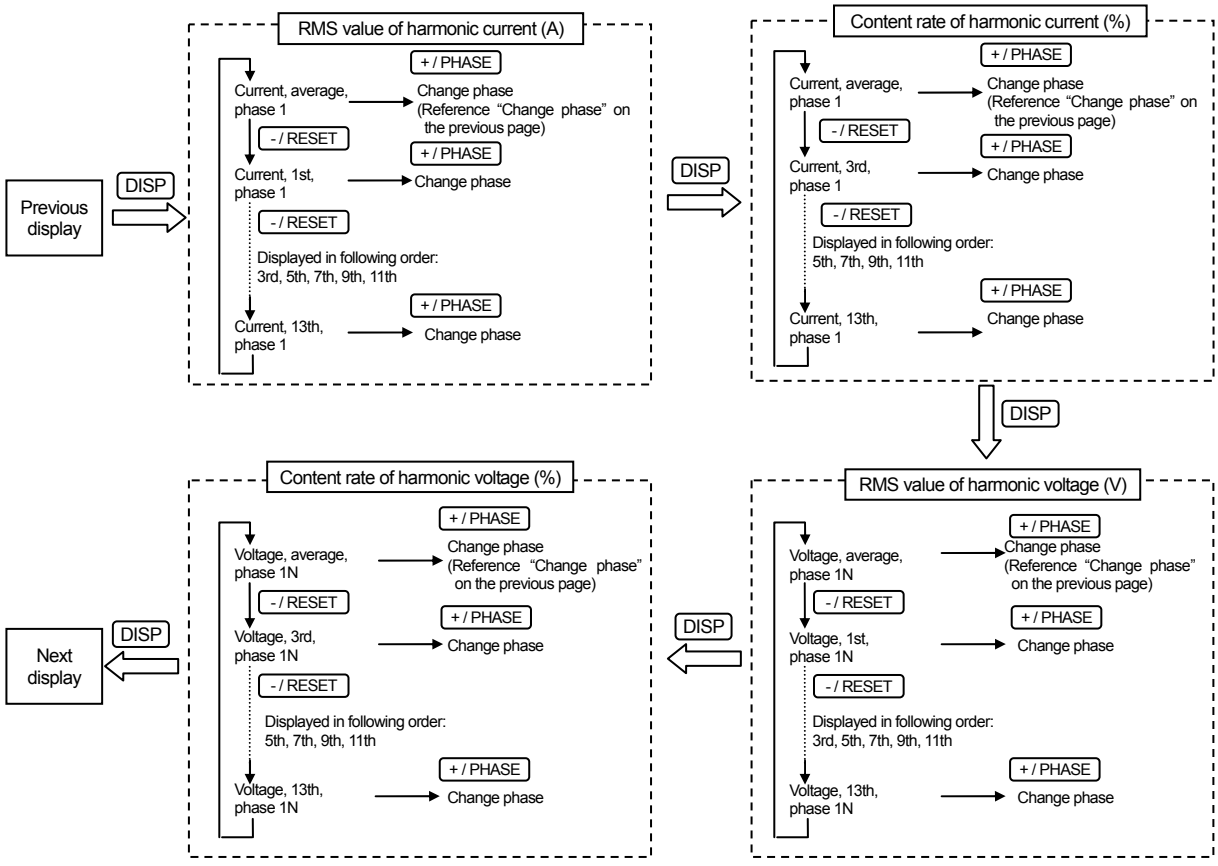
· Indication of harmonic

This unit can indicate the RMS value of harmonic, distortion rate and content rate. To indicate them, the indication setting of harmonic is needed in advance.
(For indication setting of harmonic, refer to pp. 21 - 22.)

- Measured element

Order	Harmonic current		Phase N harmonic voltage		Harmonic voltage	
	RMS value	Distortion rate (Content rate)	RMS value	Distortion rate (Content rate)	RMS value	Distortion rate (Content rate)
Total of harmonic	○	○	○	○	○	○
1st	○	-	○	-	○	-
3rd	○	○	○	○	○	○
5th	○	○	○	○	○	○
7th	○	○	○	○	○	○
9th	○	○	○	○	○	○
11th	○	○	○	○	○	○
13th	○	○	○	○	○	○

- Transition diagram for indication of harmonic (change degree)



Supplement: Harmonic total is shown by "ALL". (Display sample P.49).

Measured item indication in operating mode

· Indication of electric energy, reactive energy and periodic energy

- Indication format

The indication format of electric energy, reactive energy and periodic energy is as follows depending on the full load power:

$$\text{Full load power [kW]} = \frac{\alpha \times (\text{VT primary voltage}) \times (\text{CT primary current})}{1000}$$

α: 1 Single-phase, 2-wire
2 Single-phase, 3-wire
$\sqrt{3}$ Three-phase, 3-wire
3 Three-phase, 4-wire

*1: VT primary voltage in single-phase 3-wire system is regarded as 110V.
*2: Using direct connection, replace VT primary voltage with direct voltage in calculation above.
*3: In three-phase 4-wire system, replace VT primary voltage or direct voltage with phase voltage in calculation above.

Full load power [kW]	Indication format	
	Digital indication	Unit
less than 12	8888.88	kWh kvarh
12 or more and less than 120	88888.8	
120 or more and less than 1200	888888	
1200 or more and less than 12000	8888.88	MWh Mvarh
12000 or more	88888.8	

· Indication of electric power, power demand, reactive power and apparent power

- Indication format

The indication format of electric power, power demand, reactive power and apparent power is as follows depending on the full load power:
(For the full load power, refer to above.)

Full load power [kW]	Indication format	
	Digital indication	Unit
less than 12	888.888	kW kvar kVA
12 or more and less than 120	8888.88	
120 or more and less than 1200	88888.8	
1200 or more and less than 12000	888888	
12000 or more	8888.88	MW Mvar MVA

· Indication of current and current demand

- Indication format

The indication style of current and current demand is as follows depending on the primary current:

Primary current [A]	Indication format	
	Digital indication	Unit
less than 40	888.888	A
40 or more and less than 400	8888.88	
400 or more and less than 4000	88888.8	
4000 or more	888888	

· Indication of voltage

- Indication style

The indication format of voltage is as follows depending on the primary voltage:

Primary voltage [V]	Indication format	
	Digital indication	Unit
less than 300	88888.8	V
300 or more	888888	

Caution: In three-phase 4-wire system, the indication of VT primary voltage and direct voltage depends on the phase voltage.

· Indication of harmonic current and harmonic voltage

- Indication format

To indicate harmonic current and harmonic voltage, the indication setting of them is needed in advance.
The indication format of them is as follows depending on the full load power:

Measured element	Indication format	
	Digital indication	Unit
RMS value of harmonic current	same as current	same as current
Distortion rate of harmonic current (Content rate)	888.8	%
RMS value of harmonic voltage	same as voltage	same as voltage
Distortion rate of harmonic voltage (Content rate)	888.8	%

· Indication of equivalent CO_2

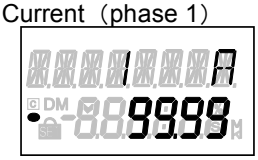
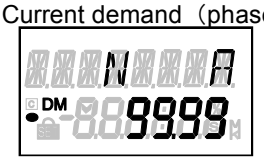
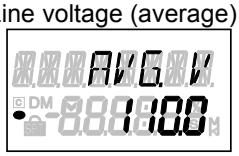
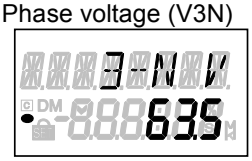
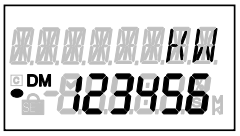
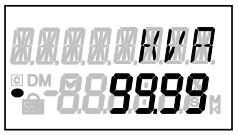
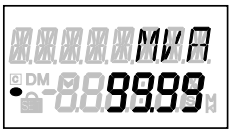
- Indication format

To indicate equivalent CO2, the indication setting of it is needed in advance.
The indication format of it is as follows depending on the full load power:

Full load power [kW]	Indication format	
	Digital indication	Unit
less than 12	8888.88	kg
12 or more and less than 120	88888.8	
120 or more and less than 1200	888888	
1200 or more and less than 12000	8888.88	t
12000 or more	88888.8	

Display examples in operating mode

- Display examples

Measured items	Display example of main module	Unit	Note
Current	Current（phase 1） 	A	
Current demand	Current demand（phase N） 	A	
Voltage	Line voltage (average)  Phase voltage (V3N) 	V	
Electric power	 	kW MW	Unit varies depending on the setting value.
Electrcic power demand	 	kW MW	Unit varies depending on the setting value.
Reactive power	 	kvar Mvar	Unit varies depending on the setting value.
Apparent power	 	kVA MVA	Unit varies depending on the setting value.
Power factor		%	
Frequency		Hz	

Measured items	Display example of main module	Unit	Note
Harmonic current	RMS value of harmonic current (1st) 	A	
	Distortion rate of harmonic current (total) 	%	
Harmonic voltage	RMS value of harmonic voltage (3rd) 	V	
	Harmonics ratio voltage (13th) 	%	
Electric energy (consumption)		kWh MWh	Unit varies depending on the setting value.
Electric energy (regenerated)		kWh MWh	Unit varies depending on the setting value.
Reactive energy (consumption lag)		kvarh Mvarh	Unit varies depending on the setting value.
Pulse-count value		-	
Periodic electric energy		kWh MWh	Unit varies depending on the setting value.
Operating time		h	
CO2 conversion setting		kg t	Unit varies depending on the setting value.

How to use upper/lower limit alarm function

This device can set the upper/lower limit alarm value for each measured value individually.

<Monitoring items>

Upper limit alarm items	Current demand, phase N current demand, Voltage, Electric power demand, Power factor, Pulse count
Lower limit alarm items	Current demand, Voltage, Electric power demand, Power factor,

<Alarm setting>

・Upper limit value　Set the upper limit of measured value. For setting value and setting range, ☛pp. 23 - 24.
・Lower limit value　Set the lower limit of measured value. For setting value and setting range, ☛pp. 23 - 24.
・Alarm delay time　Set the value in case you want to remove the inrush current of the load, etc. from the objects of monitoring. Alarm does not occur when the measured value goes below the upper limit or goes over the lower limit within the configured time. For setting value and setting range, ☛page 24.
・Alarm reset method　Alarm recovery operation is different according to the alarm reset method.

Reset method	Alarm recovery operation
Auto-reset (Auto)	Reset the alarm automatically if the measured value goes below the upper limit or goes over the lower limit.
Self-retention (HoLd)	The alarm is held after the measured value goes below the upper limit or goes over the lower limit. Alarm is cleared by alarm reset.

For setting, ☛page 24. For alarm reset operation, ☛page 51.

<Alarm occurrence / recovery condition>

Alarm item	Alarm reset method	Alarm status		Alarm occurrence / recovery condition
Current demand Phase N current demand Voltage Electric power demand Power factor	Auto-reset (Auto)	Upper limit monitoring	Occurrence	Measured value > configured upper limit (Alarm delay time is available)
			Recovery	Measured value ≤ configured upper limit
		Lower limit monitoring	Occurrence	Measured value < configured lower limit (Alarm delay time is available)
			Recovery	Measured value ≥ configured lower limit
	Self-retention (HoLd)	Upper limit monitoring	Occurrence	Measured value > configured upper limit (Alarm delay time is available)
			Retention	Measured value ≤ configured upper limit
			Recovery	Measured value ≤ configured upper limit AND Alarm reset
		Lower limit monitoring	Occurrence	Measured value < configured lower limit (Alarm delay time is available)
			Retention	Measured value ≥ configured lower limit
			Recovery	Measured value ≥ configured lower limit AND Alarm reset
Pulse count	Auto-reset (Auto)	Upper limit monitoring	Occurrence	Measured value ≥ configured upper limit
			Recovery	Measured value < configured upper limit
	Self-retention (HoLd)	Upper limit monitoring	Occurrence	Measured value ≥ configured upper limit
			Retention	Measured value < configured upper limit
			Recovery	Measured value < configured upper limit

Caution: Measured value of pulse count is integrated, so you can reduce it (i.e. clear it to zero) by the preset operation of pulse count only. For the preset operation of pulse count, ☛page 52.

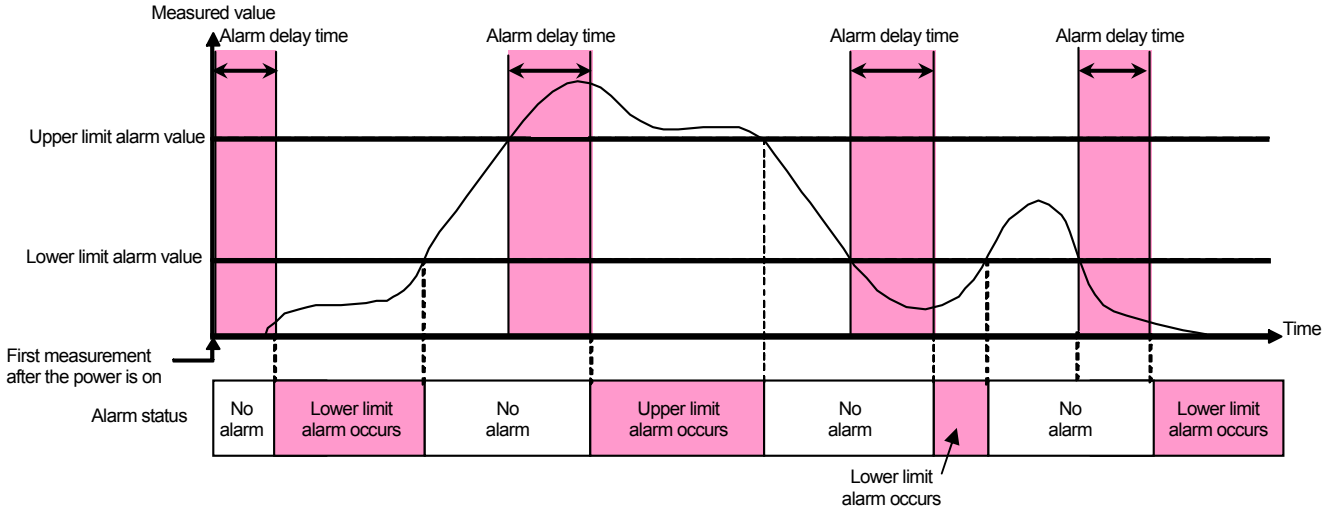
<Alarm indication at alarm status>

	No alarm	Alarm occurrence		Alarm retention	
		When indicating the alarm-occurrence phase	When indicating the other phase	When Indicating the alarm-occurrence phase	When indicating the other phase
Digital indication	Turn ON	Flash (*1)	Turn ON	Flash (*2)	Turn ON
Measured element, Unit, Phase	Turn ON	Flash (*1)	Flash (*1)	Flash (*2)	Flash (*2)

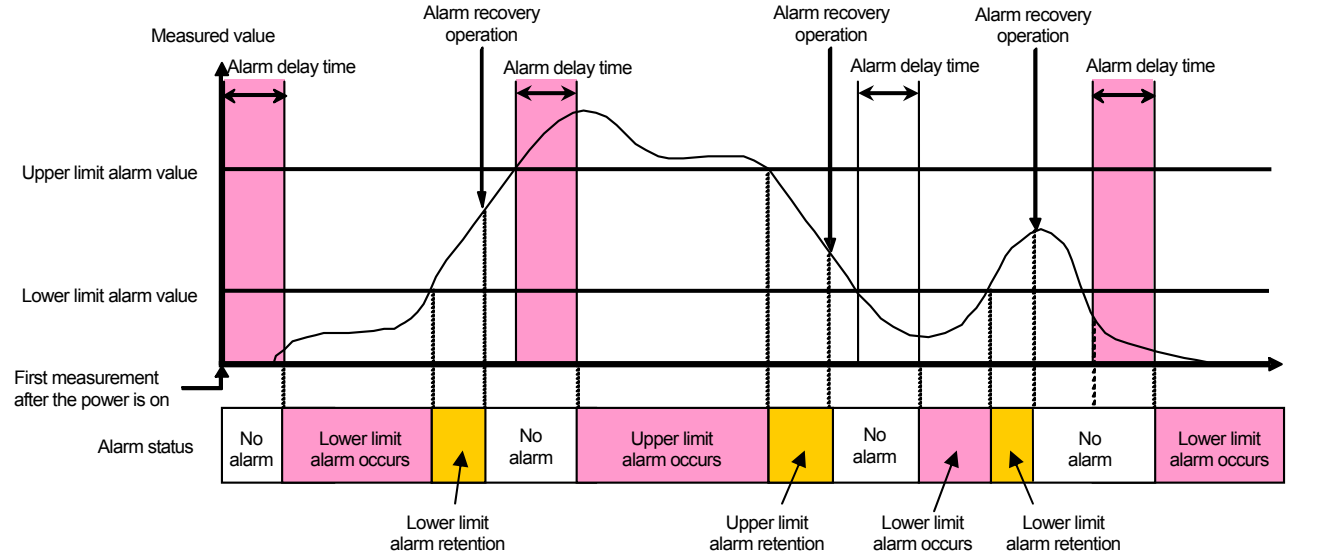
*1: Flash (250ms ON / 250ms OFF)　*2: Flash (500ms ON / 500ms OFF)

< Examples of alarm occurring (except for the upper limit of pulse count) >

(1) When the alarm reset method is “Auto-reset (Auto)”.



(2) When the alarm reset method is “Self-retention (HoLd)”.



Operations of alarm reset

· Operations of alarm reset

Alarm recovery operation is different according to the alarm reset method.

Alarm reset method	Alarm recovery operation
Auto-reset (Auto)	Reset the alarm automatically if the measured value goes below the upper limit or goes over the lower limit.
Self-retention (HoLd)	The alarm is held after the measured value goes below the upper limit or goes over the lower limit. Clear the alarm as below after the value goes below the upper limit or goes over the lower limit. ・In the present value display of operating mode, press [- / RESET] button for two seconds to clear the alarm. (Alarm clear is effective even in other than the alarm-occurrence phase.)

Preset and all data reset

You can reset all the integrated measured values or some of them to zero. (such as electric energy, operating time, etc.)

・ The integrated measured values you can reset to zero are as follows:

Electric energy, Reactive energy, Regenerative energy, Periodic energy, Pulse count, Equivalent CO_2, Operation time

- Preset (Data reset of selected value)

・ In each integrated value display of operating mode, press both [+ / PHASE] and [- / RESET] at the same time for more than two seconds to transition to preset mode.

・ Preset procedure is as follows:

Operation of preset display

・ Press [+ / PHASE] or [- / RESET] to choose the value at flashing digit.
・ Press [SET] for the setting digit (flashing digit) to shift to lower.
・ Press [DISP] for the setting digit (flashing digit) to shift to upper.
・ Press [SET] at the lowest digit to transition to preset confirmation display as right figure.
・ In preset confirmation display, choose ”yES” to reset value, then back to the integrated value display
・ In preset confirmation display, choose ”no” to cancel resetting value, then back to the integrated value display

Preset confirmation display

- All data reset

・ In each integrated value display of operating mode, press both [SET] and [+ / PHASE] at the same time for more than two seconds to transition to all-data-reset display as right figure.
・ In all-data-reset display, choose “yES” to reset all the integrated values to zero, then back to the integrated value display.
・ In all-data-reset display, choose “no” to cancel resetting, then back to the integrated value display.

All-data-reset display

Measured items

The table below shows whether indication and output are performed or not for each measured item.

● ··· Data which are indicated and output - ··· Data which are not indicated or output

Measured item				EMU4-BD1-MB			EMU4-HD1-MB			
		Details		1P2W	1P3W	3P3W	1P2W	1P3W	3P3W	3P4W
Current		phase 1		●	●	●	●	●	●	●
		phase 2		-	●	●	-	●	●	●
		phase 3		-	●	●	-	●	●	●
		phase N		-	-	-	-	-	-	●
		Average		●	●	●	●	●	●	●
Current demand *moving average for the set period of current demand is indicated		phase 1		●	●	●	●	●	●	●
		phase 2		-	●	●	-	●	●	●
		phase 3		-	●	●	-	●	●	●
		phase N		-	-	-	-	-	-	●
Voltage		phase 12		●	●	●	●	●	●	●
		phase 23		-	●	●	-	●	●	●
		phase 31		-	●	●	-	●	●	●
		phase 1N		-	-	-	-	-	-	●
		phase 2N		-	-	-	-	-	-	●
		phase 3N		-	-	-	-	-	-	●
		Average line voltage		●	●	●	●	●	●	●
Electric power				●	●	●	●	●	●	●
Electric power demand				●	●	●	●	●	●	●
Reactive power				●	●	●	●	●	●	●
Apparent power				-	-	-	-	-	-	●
Power factor				●	●	●	●	●	●	●
Frequency				●	●	●	●	●	●	●
Harmonic current	RMS	Total 1st 3rd - 13th	phase 1	-	-	-	●	●	●	●
			phase 2	-	-	-	-	-	-	●
			phase 3	-	-	-	-	●	●	●
			phase N	-	-	-	-	-	-	●
	Distortion ratio	Total 3rd - 13th	phase 1	-	-	-	●	●	●	●
			phase 2	-	-	-	-	-	-	●
			phase 3	-	-	-	-	●	●	●
			phase N	-	-	-	-	-	-	●
Harmonic voltage	RMS	Total 1st 3rd - 13th	phase 1N	-	-	-	-	-	-	●
			phase 2N	-	-	-	-	-	-	●
			phase 3N	-	-	-	-	-	-	●
			phase 12	-	-	-	●	●	●	-
			phase 23	-	-	-	-	●	●	-
	Distortion ratio	Total 3rd - 13th	phase 1N	-	-	-	-	-	-	●
			phase 2N	-	-	-	-	-	-	●
			phase 3N	-	-	-	-	-	-	●
			phase 12	-	-	-	●	●	●	-
			phase 23	-	-	-	-	●	●	-
Electric energy		Consumption		●	●	●	●	●	●	●
		Regeneration		●	●	●	●	●	●	●
		Consumption (extended) (*1)		●	●	●	●	●	●	●
		Regeneration (extended) (*1)		●	●	●	●	●	●	●
Reactive energy		Consumption lag		●	●	●	●	●	●	●
		Consumption lag (extended) (*1)		●	●	●	●	●	●	●
External input	Pulse input	Pulse count		-	-	-	●	●	●	●
	Contact input	Periodic electric energy		-	-	-	●	●	●	●
Operating time				●	●	●	●	●	●	●
Equivalent CO2 (*2)				-	-	-	●	●	●	●

*1: Output is supported, but indication is not supported.

*2: Indication is supported, but communication is not supported.

✓ **Supplement** ----------

The table below shows how to calculate the average value.

Item	Phase-wire system	Calculating formula
RMS current value (Average)	Single-phase 2-wire	RMS current value (Average) = phase 1 current
	Single-phase 2-wire Three-phase 3-wire	RMS current value (Average) = (phase 1 current + phase 3 current) / 2
	Three-phase 4-wire	RMS current value (Average) = (phase 1 current + phase 2 current + phase 3 current) / 3
RMS voltage value (Average)	Single-phase 2-wire	RMS voltage value (Average) = voltage V12
	Single-phase 2-wire Three-phase 3-wire	RMS voltage value (Average) = (voltage V12+ voltageV23) / 2
	Three-phase 4-wire	RMS voltage value (Average) = (voltage V12 + voltage V23+ voltage V31) / 3

Restrictions of measured data

F/W version is displayed in five seconds after the power loading to this device.
Measurement and communication do not performed in a few seconds after the configuration or the change of the rating to it.
Behaviors during operation are as follows:

Measured item	Behaviors of this device	
	Display part indication	Communication data
Current	Indicate “0A” if RMS value is under 0.4% range of rating. Indicate upper indication limit value if RMS value is over it.	Same as on the left
Current demand	Indicate upper indication limit value if RMS value is over it.	Same as on the left
Voltage (*1)	Indicate “0V” if RMS value is under 11V. Indicate upper indication limit value if RMS value is over it.	Same as on the left
Power Power demand Reactive power Apparent power	Indicate “0W”, “0var” or “0VA” if indicated voltage values of all phases are 0V or indicated current values of them are 0A. Indicate upper indication limit value if the measured value is over it.	Same as on the left
Power factor	Indicate “100.0%” if indicated voltage values of all phases are 0V or indicated current values of them are 0A	Same as on the left
Frequency	Voltage condition: Indicate “----” if voltage V12 (voltage V1N for 3P4W) is 0V.	0
	Frequency condition: Indicate “----” if frequency is under 44.5Hz.	44.5
RMS value of harmonic current	Voltage condition: Indicate “----” at all phase if voltage V12 (voltage V1N for 3P4W) is under 11V. Indicate “0V” at all phase if voltage V12 (voltage V1N for 3P4W) is under 40V.	0 0
	Frequency condition: Indicate “----” at all phases if frequency is under 44.5Hz.	0
Content rate of harmonic current (modulation distortion)	Voltage condition: Indicate “----” at all phase if voltage V12 (voltage V1N for 3P4W) is under 11V. Indicate “0.0%” at all phase if voltage V12 (voltage V1N for 3P4W) is under 40V.	0 0
	Frequency condition: Indicate “----” at all phases if frequency is under 44.5Hz.	Outside-channel error
RMS value of harmonic voltage	Voltage condition: Indicate “----” at all phase if voltage V12 (voltage V1N for 3P4W) is under 11V. Indicate “0V” at all phase if voltage V12 (voltage V1N for 3P4W) is under 40V.	0
	Frequency condition: Indicate “----” at all phases if frequency is under 44.5Hz.	0
Content rate of harmonic voltage (modulation distortion)	Voltage condition: Indicate “----” at all phase if voltage V12 (voltage V1N for 3P4W) is under 11V. Indicate “0.0%” at all phase if voltage V12 (voltage V1N for 3P4W) is under 40V.	0
	Frequency condition: Indicate “----” at all phases if frequency is under 44.5Hz.	0
Pulse count	When use of upper / lower limit alarm = oFF or upper / lower limit alarm element ≠ pulse count (upper limit), counting restarts from 0 when 999999 have been exceeded. When use of upper / lower limit alarm = on and upper / lower limit alarm element = pulse count (upper limit), it is fixed to 999999 when 999999 have been exceeded.	Same as on the left
Operating time (*2)	Indicate “999999h” if operating time is over 999999h.	Same as on the left

*1: In single-phase, three-wire system, indicate “0V” if RMS value is under 22V.
*2: Operation time is reference value.

10. Reference

This chapter explains the ways of dealing when you think the unit is in failure, Q&A, etc.

In case you think the unit is in failure

If an abnormal sound, bad-smelling smoke, fever break out from this unit, switch it off promptly and don't use it. If you think the unit is in failure, check the following before sending for repair.

Obtained value is incompatible with other values.

- **Integrated electric energy value is not measured though current value is indicated.**
- **Obtained values are different from other measuring instruments.**

Check the connection to the terminals of "Power supply side (K)" and "Load side (L)".

Check the settings of phase wire system, primary voltage and primary current.
Wrong settings may cause the incorrect measurement.

Check whether the short circuit or disconnection is present.

Obtained values are different from other measuring instruments. (over tolerance)

Check that the measuring instrument used for comparison indicates a correct RMS value. This unit indicates an RMS value.

If the measuring instrument used for comparison measures an average value instead of RMS value, distortion caused by harmonic etc. in the current of the circuit to be measured causes a significant difference of values.

About error number

In case the display part indicates the error number as below, adopt measures indicated in the table below.
If the unit does not resume after measures, it may be in failure. Contact our sales representative near you.

(Example) Error No.005

Error No.	Kind of Error	Measures
002	FRAM error	Press the reset button until the display (LED) turns off. or Restore auxiliary power supply.
003	Memory error	
004	Timeout error	
005	Outside-set-value error	Press [SET] button
009	Communication module error	Make sure that the communication module is connected properly, then turn on the power again auxiliary.

After-sales service

If you have any questions or the product is broken down, contact our sales representative near you. (For details, refer to the end of this manual.)

- Gratis warranty is effective until the earlier of 1 year after the date of your purchase or 18 months after manufacturing.
- The gratis warranty shall apply if the product fails even though it is being used properly in the conditions, with the methods and under the environments in accordance with the terms and precautions described in the catalogs, the instruction manual, caution label on the product, etc.
- Repair shall be charged for the following cases even during the gratis warranty period.
  - Failures occurring due to your improper storage or handling, carelessness or fault.
  - Failures due to faulty workmanship
  - Failures due to faults in use and undue modification
  - Failures due to accidental force such as a fire, abnormal voltage, etc. and force majeure such as an earthquake, wind, flood, etc.
  - Failures due to matters unpredictable based on the level of science technology at the time of product.
- Our company shall not be liable to compensate for any loss arising from events not attributable to our company, opportunity loss and lost earning of the customer due to failure of the product, and loss, secondary loss, accident compensation, damage to other products besides our products and other operations caused by a special reason regardless of our company's predictability

Q&A

· General

Q **To what degree is the unit durable against overvoltage and over current?**

A
Durability is as follows:
Momentary*: Up to 10 times as high as rated current and 2 times as high as rated voltage.
*Momentary means: Energizing 9 times for 0.5 seconds at 1-minute intervals, and then 1 time for 5 seconds.
Continuous: Up to 1.2 times as high as rated voltage and rated current.

Q **Can the unit be used as an electric energy meter?**

A This unit cannot be used for deal and proof of electric energy measurement stipulated in the measurement law.

Q **Are errors in wiring verifiable easily?**

A They are verifiable by the indication for discrimination support function for improper connection.(☛pp.32-41)

Q **If a load such as welding equipment exists, a current flows only for a short period (e.g. 2 cycles). Is measurement possible?**

A
This unit makes measurement with a sampling period of 4340 Hz (for both 50 Hz and 60 Hz).
The electrical amount such as current, voltage, electric power, power factor, frequency, harmonic voltage and harmonic current is measured in a cycle of 250 ms period. So it is impossible to measure the current accurately for a short period.
The amount of electricity and reactive power amount are measured separately from the momentary data described above, using a sampling period of 4340 Hz continuously without intermittence. Therefore, it is possible to measure the load for a short period.

Q **Is it OK to open the secondary terminals of the current sensor?**

A
The secondary side of the models EMU2-CT5, EMU2-CT5-4W, EMU-CT50, EMU-CT100, and EMU-CT250 is equipped with the protective circuit against opening of secondary terminals. Opening them during the wiring work causes no problems. However, for safety, please do not continuously energize the module with the terminals open.
The secondary side of the models EMU-CT400 and EMU-CT600 is equipped with the protective circuit against opening of secondary terminals. However, during the wiring work, be sure to turn the secondary side short-circuit switch to short. After completion of work, be sure to turn the secondary short-circuit switch to open. Note that failing to turn the switch open results in an inaccurate measurement.

Q **Obtained values may be different from other measuring instruments. Why is it so?**

A
There are various possible causes. Check the following first, please:
(1) Check for wiring errors.
(2) Check for the settings. (phase wires, primary voltage ,primary current and sensor type)
(3) On the split-type current sensor, check for the poor engagement or separation of fitting surfaces.
(4) On the split-type current sensor, check for pinching of foreign object between fitting surfaces.
(5) Check for the short circuit on the secondary side of the current transformer (CT).
(6) Current sensor connectable to the unit is the dedicated current sensor only. Check that the proper current sensor is connected or not.
(7) Check that the measuring instrument used for comparison indicates a correct RMS value.
This unit indicates an RMS value. If the measuring instrument used for comparison measures an average value instead of RMS value, distortion caused by harmonic etc. in the current of the circuit to be measured causes a significant difference of values.

· Q&A about specifications

Q	**What does "Allowable tolerance" mean?**
A	In terms of the amount of electricity, it means a range of tolerances in reading values. For example, when the reading value is "10 kWh," a tolerance is ±0.2 kWh. In terms of measured elements other than the amount of electricity, it means tolerance for the rated input. For a current, when a rated current is set to 5 A, ±1% of 5 A is a tolerance.

Q	**Is accuracy of a current sensor included?**
A	Accuracy of a current sensor is not included in accuracy of the unit. A maximum value of tolerance is obtained by summing tolerance of the unit and that of a current sensor.

Q	**To what degree an area of micro current is measured?**
A	A current value is measured from the area exceeding 0.4% of the rated current. In an area below 0.4%, measurement result is indicated as "0" (zero). However, in that case, still, the amount of electricity is being measured. Even if the indicated value is "0," measurement value will increase in continuing measurement for a long time. The amount of electricity is measured with a load that is about 0.4% or more of all load power.

· Q&A about installation

Q	**What is wire diameter that allows installing a current sensor?**
A	The following lists the nominal cross-sectional areas of the conductor of 600-V vinyl coated wires that can penetrate. (values for reference) · IV wire (600-V vinyl insulated wire) 60mm^2 (EMU-CT50/CT100), 150mm^2 (EMU-CT250) 500 mm^2 x 1 wire, 325 mm^2 x 2 wires (EMU-CT400/CT600) · CV wire (600-V vinyl insulated wire) 38mm^2 (EMU-CT50/CT100), 150mm^2 (EMU-CT250, 100mm^2 is recommended) 500 mm^2 x 1 wire, 325 mm^2 x 2 wires (EMU-CT400/CT600) The above shows the standard nominal cross-sectional areas. Due to the outer difference of finished vinyl insulation and deformation (bending) depending on manufacturers, a wire may not penetrate. Make verification on site.

Q	**What are the points when installing a current sensor?**
A	Models EMU2-CT5, EMU2-CT5-4W, EMU-CT50, EMU-CT100, EMU-CT250, EMU-CT400 and EMU-CT600 are split-type. If split surfaces are not engaged sufficiently or a foreign object exists between the split surfaces, adequate performances are not obtained. Pay attention in installation.

· Q&A about connection

Q	**Does polarity exist in connection between a current sensor and the unit?**
A	Yes. Make connections so that secondary terminals of current sensor (k, l) and terminal symbols of unit agree with each other. If polarity is incorrect, the current value is measurable, but the electric power and the electrical energy cannot be measured correctly.

Q	**Are there any key points in avoiding errors in wiring?**
A	Check polarity of current sensor on the primary current side. Power supply side of the circuit is indicated as "K," and the load is indicated as "L." An arrow indicates the direction from K to L. Check the current sensor and the module are connected correctly for the 1-side circuit, 2-side circuit, and 3-side circuit. Besides, check that voltage inputs for voltage transform unit are connected correctly among P1, P2, P3, and P0.

Q	**How do wires extend between a current sensor and the module?**
A	Model EMU-CT50, EMU-CT100, EMU-CT250, EMU-CT-400, EMU-CT600 are extendable up to 50m. Model EMU2-CT5, EMU2-CT5-4W are extendable up to 10.5 m, using together with a cable supplied with the sensor. To extend the wire further, use the current transformer CW-5S(L) for split-type instrument in combination, extending the secondary wiring on CW-5S(L) side.

· Q&A about setting

Q	**Is the setting required?**
A	At least, settings of phase wires, rated current and rated voltage are required. Specify settings in accordance with a circuit to be connected.

Q	**If a primary current setting value is different from that of rated current on a connected current sensor, does it cause a breakdown?**
A	It does not cause breakdown or burning. However, measurement values will be totally incorrect.

11. Requirement for the compliance with EMC Directives

EMC Directives prescribe both “Emission (electromagnetic interference): Do not radiate strong electromagnetic waves outside” and “Immunity (electromagnetic susceptibility): Do not be influenced by electromagnetic waves from outside”.

This section compiles the precautions for the compliance of the system incorporating the energy measuring unit (target model: EMU4-BD1-MB and EMU4-HD1-MB) with the EMC Directives. The following description is based on the requirement of the regulations and the standards we understand, but we do not guarantee to comply with the directives above for the whole system built in accordance with this description. The manufacturer of the system finally needs to evaluate the way of the compliance with EMC Directives and whether the system complies with them or not.

(1) Harmonized standard for EMC Directives: EN61326-1:2006

(a) Compatibility condition for harmonized standard

The energy measuring unit is the open type device (i.e. the device incorporated in other device), and needs to be installed in the conductive control panel. The unit is tested with installed in the control panel for the emission and the immunity out of the test items for the standard.

(2) Recommended condition for installation in the control panel

(a) Control panel

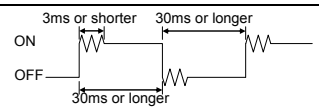
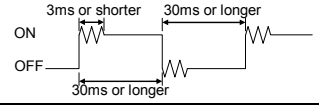
- Control panel needs to have conducting property.
- When bolting the top panel, bottom panel etc. of the control panel, mask the grounding part of the panel so as not to be painted.
- In inner panel, keep the conductivity in as large area as possible by masking the bolting part to the main panel to keep the electric contact to main panel.
- Ground the main panel by the thick wire so as to keep high impedance even for high-frequency wave.

(b) Installation of power line and ground line

- Set up the ground point to the control panel near the energy measuring unit, and ground the frame GND terminal of the unit to the ground terminal of the control panel (PE) by as thick and short wires as possible. (wire length is 30cm or shorter)

12. Specifications

Common specifications

Item			Specifications	
Model			EMU4-BD1-MB	EMU4-HD1-MB
Phase-wire system			Single-phase 2-wire / Single-phase 3-wire / Three-phase 3-wire (Change of setting)	Single-phase 2-wire / Single-phase 3-wire / Three-phase 3-wire / Three-phase 4-wire(Change of setting)
Rating	Voltage circuit	Single-phase 2-wire / Three-phase 3-wire	110V, 220V AC(*1)	110V, 220V, 440V AC(*2)
		Single-phase 3-wire	AC110V (b/w 1- and 2-phase, 2- and 3-phase), AC220V (b/w 1- and 3-phase)	
		Three-phase 4-wire	-	Min: 63.5V/110V AC, Max: 277V/480V AC(*3)
	Current circuit (*1)		50A, 100A, 250A, 400A, 600A AC (The dedicated split type current sensor is used. Each value refers to the current at the primary side of the current sensor.) 5A AC (The dedicated split type current sensor is used. 5A current sensor is used together with the current transformer (CT), and the primary-side current is configurable up to 6000A.) (*4)	
	Frequency		50Hz / 60Hz (Auto-detect)	
Auxiliary power supply rating			100V - 240V AC (+10%, -15%) 50Hz / 60Hz	
Measurable circuit count			1 circuit	
Consumption VA	Voltage circuit		Each phase 0.1VA (at 110V AC), 0.2VA (at 220V AC), 0.4VA (at 440V AC)	
	Auxiliary power supply circuit		At 110V AC: 9VA At 220V AC: 10VA	
Allowable tolerance (*5)			Current, voltage, electric power, reactive power, apparent power, frequency : ±1.0% (100% of the rating) Power factor : ±3.0% Electric energy : ±2.0% (5 - 100% range of the rating, power factor=1) Reactive energy : ±2.5% (10 - 100% range of the rating, power factor=0) Harmonic current, harmonic voltage (*2) : ±2.5%	
Data update interval			250msec *Integrated values of electric energy and reactive energy are always accumulated (following up the short-cycled load fluctuation)	
Range of demand time setting			0, 10s, 20s, 30s, 40s, 50s, 1 - 15min (1min intervals), 20min, 25min, 30min	
External input	Input signal		-	Non-voltage Form A contact, 1 input (choose the function from below)
	Function		-	Setting to "pulse input" : Pulse count (0 - 999,999 counts)
			-	Setting to "contact input" : Contact monitoring only : Contact monitoring and energy measuring at work (when contact is on)
	Isolation		-	By photo coupler
	Rated input voltage and current		-	Voltage of the contact is 5V DC, and current is 7mA, so use something appropriate for the switching condition.
	Input condition	Pulse	-	Pulse ON time: 30ms or longer Pulse OFF time: 30ms or longer Chattering time: 3ms or shorter 
		Contact	-	Contact ON time: 30ms or longer Contact OFF time: 30ms or longer Chattering time: 3ms or shorter 
External output	Output signal		-	Non-voltage Form A contact, 1 output (choose the function from below)
	Function		-	Upper limit monitoring of current demand, Lower limit monitoring of current demand, Upper/Lower limit monitoring of voltage, Upper limit monitoring of power demand, Lower limit monitoring of power demand, Upper/Lower limit monitoring of power factor, Upper limit monitoring of pulse count, Lower limit monitoring of pulse count Selectable from either auto-reset or self-retention
	Isolation		-	By semiconductor relay
	Rated switching voltage and current		-	35V DC, 75mA 24V AC, 75mA (power factor = 1)
Pulse output	Output element		-	Electric energy
	Output signal		-	Non-voltage Form A contact, 1 output ・Unit of pulse (kWH / pulse): 0.001 / 0.01 / 0.1 / 1 / 10 / 100
	Isolation		-	By semiconductor relay
	Rated switching voltage and current		-	35V DC, 75mA 24V AC, 75mA (power factor = 1)
	Output pulse width		-	0.1 – 0.15s

Item			Specifications	
Model			EMU4-BD1-MB	EMU4-HD1-MB
Compensation for power failure	Stored items		Setting values, Electric energy (consumption, regeneration), reactive energy, periodic electric energy, pulse count value, Operating time (stored in the nonvolatile memory)	
Standard			EMC: EN-61326-1: 2006 Safety: EN-61010-1: 2010	
Usage environment	Operating temperature		-5 - +55°C (Daily average temperature is 35°C or lower)	
	Operating humidity		30 - 85%RH (No condensation)	
	Storage temperature		-10 - +60°C	
	Operating altitude		1000m or below	
Commercial frequency withstand voltage			B/w all terminals (except for communication circuit and frame GND terminal) and casing: 2000V AC, 1min	
			B/w all terminals of current input, voltage input / auxiliary power : 2000V AC, 1min	
			B/w all terminals of current input, voltage input, auxiliary power and all terminals of digital / pulse input, pulse / alarm output, communication: 2000V AC, 1min	
Insulation resistance			10MΩ or more at the same part above (500V DC)	
Appropriate wire	Terminals of auxiliary power circuit and voltage input		AWG24-16 (single/stranded)	AWG26-14 (single/stranded)
	Terminals of current input and input/output		AWG22-14 (single/stranded)	
Tightening torque	Screws for terminals of auxiliary power circuit and voltage input		0.8 N·m	0.8 - 1.0N·m
	Screws for terminals of current input and input/output		0.5 - 0.6N·m	
	Screws for installation to the panel		0.63N·m	
Mass			0.2kg	0.3kg
External dimensions (unit: mm)			75 (W) x 90 (H) x 75 (D) (expect for the protruding portions)	
Product life expectancy			10 years (under usage environmental condition indicated above)	

*1: 110V, 220V AC can connected to this unit directly. For the circuit over this voltage, transformer (VT) is necessary (primary voltage of the transformer is up to 6600V).

*2: 110V, 220V, 440V AC can connected to this unit directly. For the circuit over this voltage, transformer (VT) is necessary (primary voltage of the transformer is up to 6600V).

*3: 63.5/110V – 277/480V AC can connected to this unit directly. For the circuit over this voltage, transformer (VT) is necessary (primary voltage of the transformer is up to 6600V).

*4: Configurable primary current when using 5A current sensor is as follows:
5A, 6A, 7.5A, 8A, 10A, 12A, 15A, 20A, 25A, 30A, 40A, 50A, 60A, 75A, 80A, 100A, 120A, 150A, 200A, 250A, 300A, 400A, 500A, 600A, 750A, 800A, 1000A, 1200A, 1500A, 1600A, 2000A, 2500A, 3000A, 4000A, 5000A, 6000A
(at “any setting” CT primary current is configurable up to 6000A, but CT secondary current is fixed to 5A.)

*5: For relative error of current sensor, refer to chapter 13 “Option devices” section (1).

Specifications of MODBUS® communication

Item	Specifications
Physical interface	RS-485 2wires half duplex
Protocol	ModBus RTU mode
Transmission method	Asynchronous
Transmission wiring type	Multi-point bus (either directly on the trunk cable, forming a daisy-chain)
Baud rate	2400, 4800, 9600, 19200, 38400bps (default: 19200bps)
Data bit	8
Stop bit	1, 2 (default: 1)
Parity	ODD,EVEN,NONE (default: EVEN)
Slave address	1～255 (FFh) (default: 1) 0: Broadcast
Response time	1s or shorter from completion of receiving query data to response transmission
Transmission distance	1200m
Maximum connectable devices	31 devices
Termination resistor	120Ω 1/2W
Recommended cable	SPEV(SB)-MPC-0.2 × 3P (Mitsubishi cable industries)

13. Option devices

(1) Specifications

· Split type current sensor

Item	Specifications				
Model	EMU-CT50	EMU-CT100	EMU-CT250	EMU-CT400	EMU-CT600
Rated primary current	50A AC	100A AC	250A AC	400A AC	600A AC
Rated secondary current	16.66mA	33.33mA	66.66mA	66.66mA	66.66mA
Rated load	0.1VA				
Maximum operating voltage	460V AC				
Relative error	±1% (5 - 100% range of rating, RL ≤ 10Ω)				
Variability of phase difference	±0.5°(5 - 100% range of rating, RL ≤ 10Ω)				
Over voltage category	III				
Pollution degree	2				
Operating temperature	-5 - +55°C (Daily average temperature is 35°C or lower)				
Operating humidity	5 - 95%RH (No condensation)				
Standard for CE marking	EN61010-2-32				
Maximum operating voltage for compliance with CE marking	460V AC				
Mass (per device)	0.1kg			0.7kg	

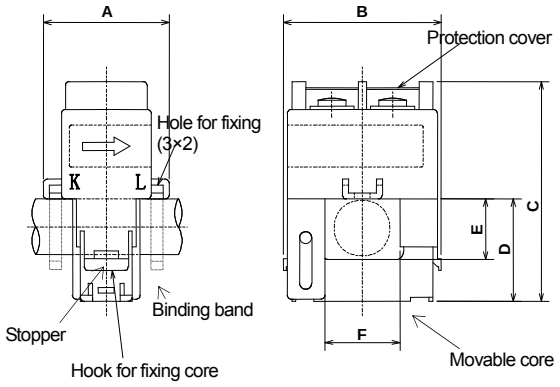
· 5A current sensor

Item	Specifications
Model	EMU2-CT5, EMU2-CT5-4W
Rated primary current	5A AC
Rated secondary current	1.66mA
Rated load	0.1VA
Maximum operating voltage	260V AC
Relative error	±1% (5 - 100% range of rating)
Variability of phase difference	±0.5°(5 - 100% range of rating, RL ≤ 10Ω)
Over voltage category	III
Pollution degree	2
Operating temperature	-5 - +55°C (Daily average temperature is 35°C or lower)
Operating humidity	5 - 95%RH (No condensation)
Standard for CE marking	EN61010-2-32
Maximum operating voltage for compliance with CE marking	260V AC
Mass (per device)	0.1kg

(2) External dimensions

· Current sensor

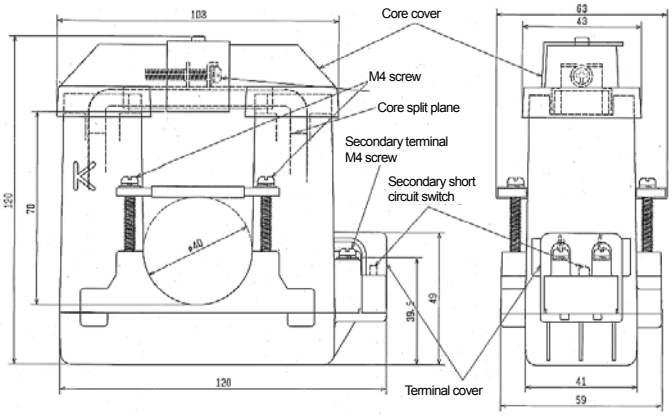
- Split type current sensor EMU-CT50, EMU-CT100, EMU-CT250



Model	A	B	C	D	E	F
EMU-CT50/CT100	31.5	39.6	55.2	25.7	15.2	18.8
EMU-CT250	36.5	44.8	66.0	32.5	22.0	24.0

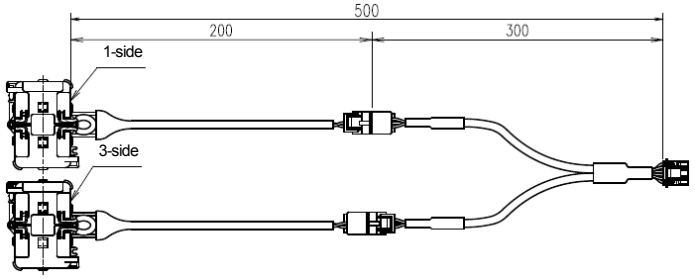
Unit: mm

- Split type current sensor EMU-CT400, EMU-CT600



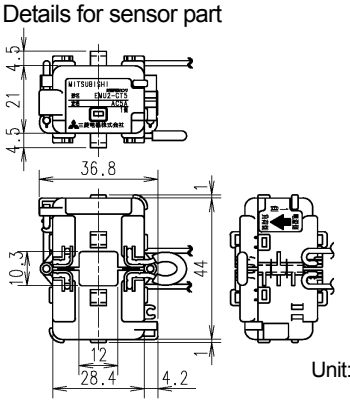
Unit: mm

- Split type 5A current sensor EMU2-CT5



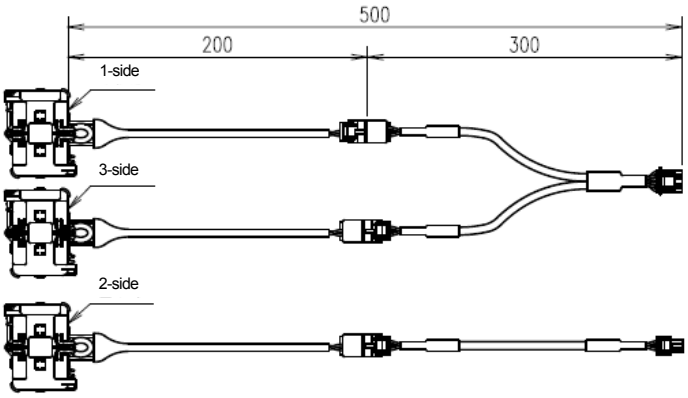
Unit: mm

Details for sensor part



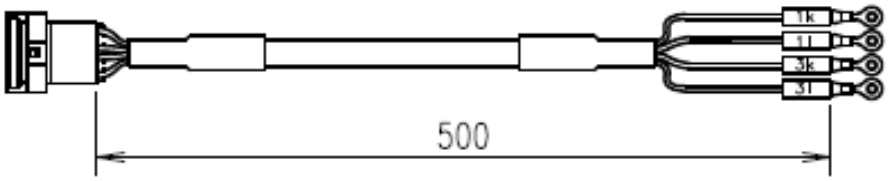
Unit: mm

- Split type 5A current sensor EMU2-CT5-4W



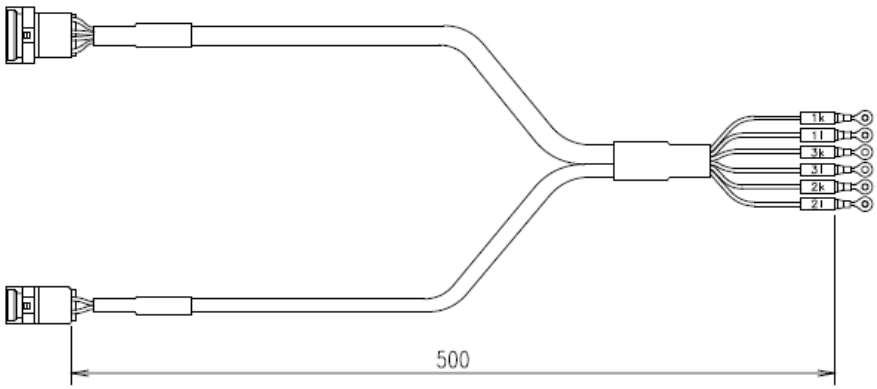
· Current sensor cable

- Split type 5A current sensor cable EMU2-CB-Q5B



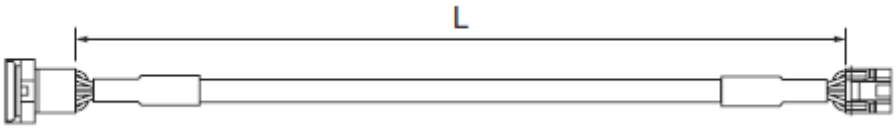
Unit: mm

- Split type 5A current sensor cable EMU2-CB-Q5B-4W



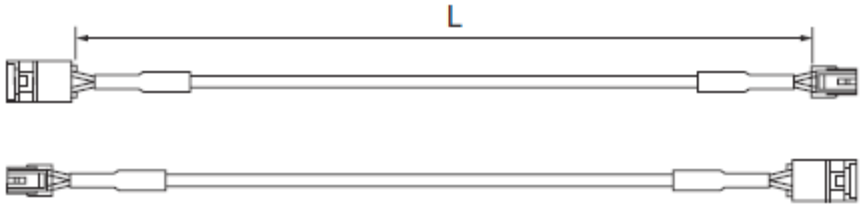
Unit: mm

- Split type 5A current sensor extension cable (standard type) EMU2-CB-T**M



Model	EMU2-CB-T1M	EMU2-CB-T5M	EMU2-CB-T10M
L size	1m	5m	10m

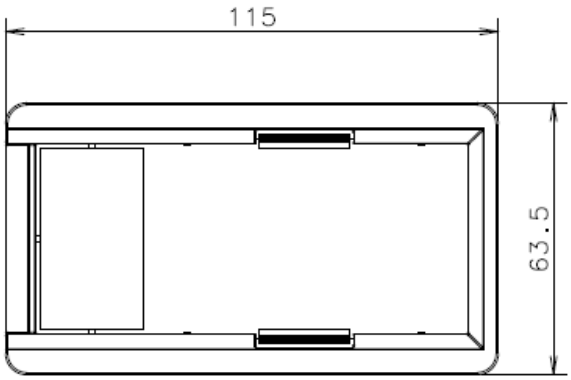
- Split type 5A current sensor extension cable (separate type) EMU2-CB-T**MS



Model	EMU2-CB-T1MS	EMU2-CB-T5MS	EMU2-CB-T10MS
L size	1m	5m	10m

· Part for installation to panel

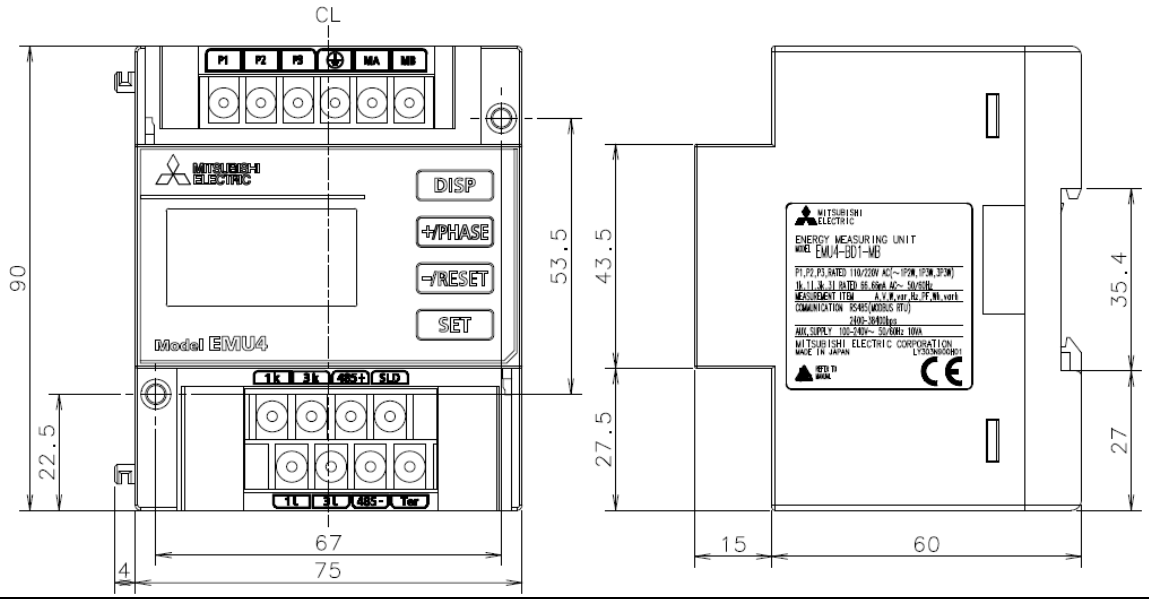
- Attachment for installation to panel EMU4-PAT



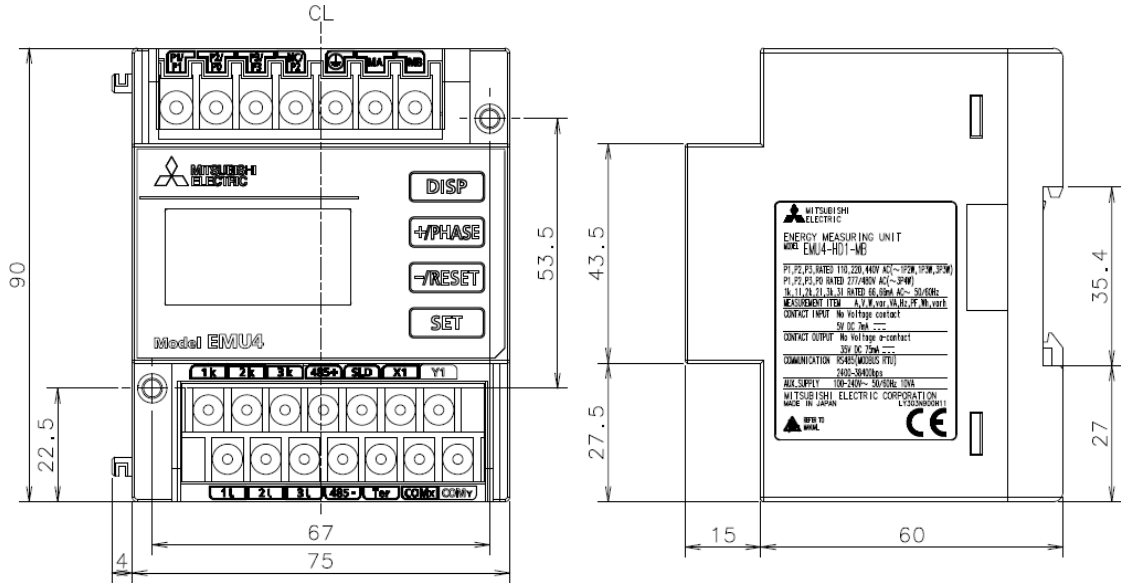
14. External dimensions

Unit: mm

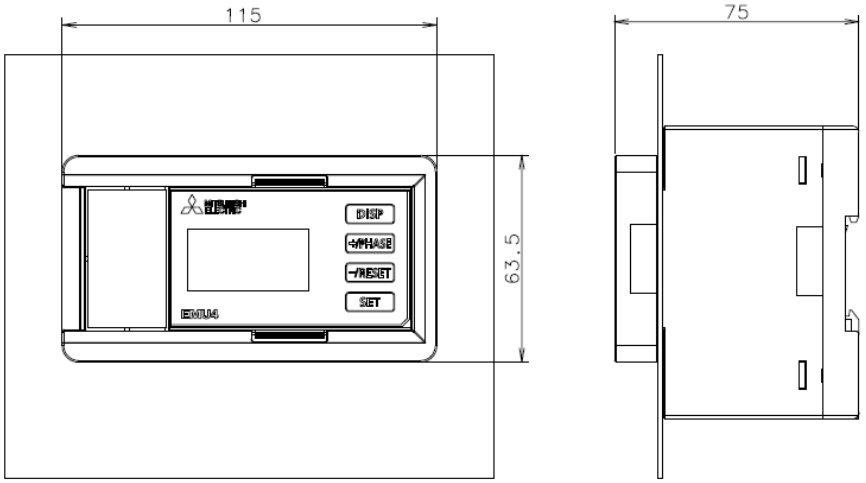
· EMU4-BD1-MB



· EMU4-HD1-MB



· When installing the attachment



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16. Customer service

Please contact us at the following location.

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Phone: +81-84-926-8142

IB63771